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Unified Central Stations

CONSOLIDATION AND CONNECTION OF STEAM, GAS ENGINE AND HYDRO PLANTS IN LORAIN COUNTY, OHIO, IMPROVE SERVICE AND INCREASE LOAD FACTOR

DURING THE PAST 2 YR., a number of companies operating electric power plants in Lorain Co., Ohio, have either sold their interests to H. L. Doherty & Co. or made arrangements by which power may be purchased from the Doherty Co. By tying these plants together with high tension transmissions lines, building and equipping necessary substations and rehabilitating the old power plants, a unified electric system has been developed which makes a continued interruption of service from any of the substations almost impossible.

In Elyria, 3 companies were taken over, these were the Ely Realty Co., the Citizens Gas & Electric Co., and the Elyria Milling & Power Co. Each of these companies operated its own power plant and maintained its own distribution lines.

At Lorain, the power plant owned by the Baltimore & Ohio R. R., known as the Lakeside Power Station, which had been used exclusively for operating the ore

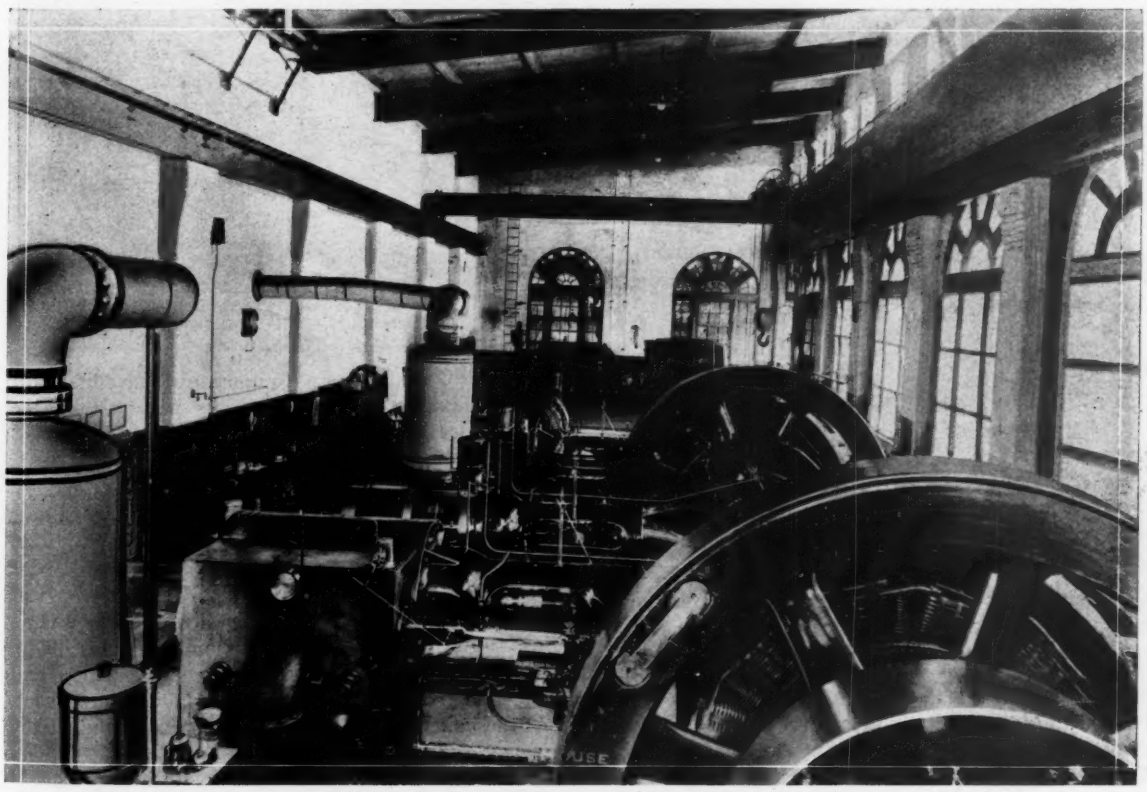


FIG. 6. GENERAL VIEW IN ENGINE ROOM OF LAKESIDE POWER STATION

docks and shops of the railway company, was secured and new modern machinery added to the equipment. This plant is now used as the generating station.

The Citizens Gas & Electric Co. of Lorain operated a gas engine-driven plant which supplied the city with electricity for power and light. This plant was secured

FIG. 1. LAKESIDE POWER STATION

by the Doherty interests and, after the addition of a substation, is now used as a stand-by and distributing center for the city of Lorain.

All these plants have been overhauled and a great amount of machinery has been added which makes it possible to operate any or all of the generating stations to feed the transmission lines at proper voltage and frequency. Attention has been given not only to the power plants, but the distributing systems have been rearranged to give most satisfactory service and highest economy of distribution.

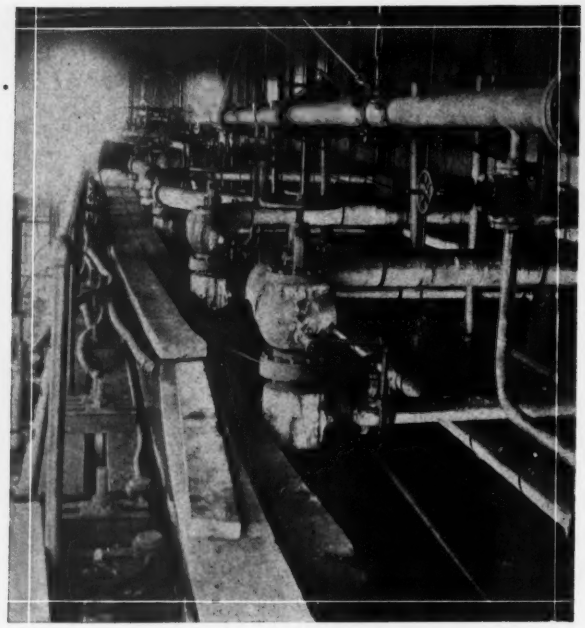


FIG. 3. VIEW OVER FRONT OF BOILERS SHOWING ARRANGEMENT OF PIPING

The initial work of this development was done by George E. Milligan acting for H. L. Doherty & Co., but since his sudden death R. E. Burger has had charge of operations. The company has not as yet been incorporated, transacting business now under the name "R. E. Burger, Agent," but it is expected to incorporate shortly under the name, "The Lorain County Power Co."

Combining the loads, which were carried by the various plants, as has been done, and carrying out an active business policy has developed an exceedingly good load factor upon the plant with accompanying economy.

Lakeside Power Station

This plant developes all the power now used by the company except in cases of emergency. The original plant and equipment were built and operated by the Baltimore & Ohio R. R. Co. to operate its machinery at the ore dock near by; but since its purchase by the Doherty interests, the plant has undergone some changes bringing it up to modern standards.

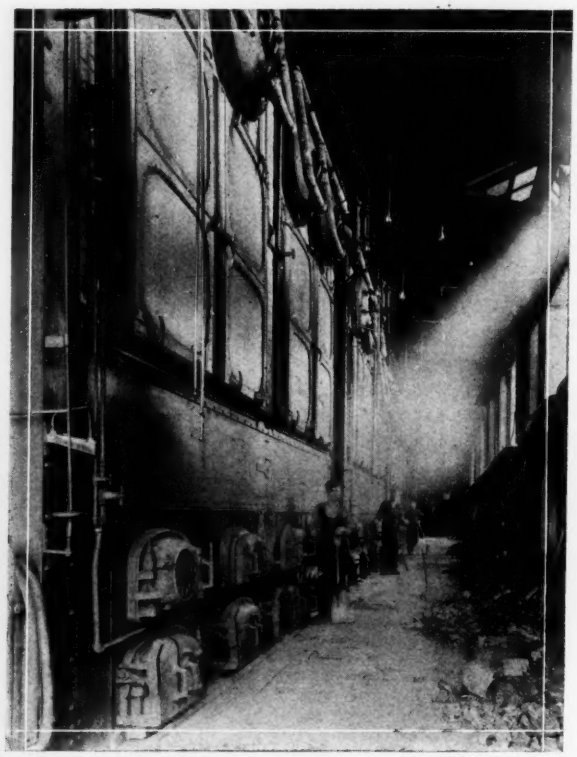


FIG. 2. BOILER ROOM, LAKESIDE POWER STATION

The steam generating equipment consists of 8 Babcock & Wilcox water-tube boilers with a total rating of 2500 hp. Five of these are 260-hp. boilers having 126 4-in. tubes 18 ft. long and 2 drums 36 in. in diameter by 20 ft. long, built for 200 lb. pressure but operated at 175. The other 3 boilers each have a rating of 400 hp., having 196 4-in. tubes 18 ft. long and 2 drums 42 in. by 20 ft. These are equipped with superheaters and supply steam at 175 lb. pressure and 100 deg. superheat. All of the boilers have vertical baffles which conduct the gases over the tubes 3 times.

McClave shaking grates are provided which are hand-fired. Firemen are aided in their work by a combina-

tion of 2 Ellison draft gages, one giving the draft over the furnace, the other a differential between the furnace and the uptake on the boiler side of the damper. With the aids provided the firemen maintain a very even flue gas analysis which, according to the Hays automatic CO_2 and draft recorder averages about 11 per cent, while the flue gas temperature normally runs at about 520 deg. A close estimate shows a fuel consumption of less than 3 lb. bituminous mine run per kilowatt-hour at the board. On each of the 5 260-hp. boilers are 2 Consolidated pop safety valves 3½ in. in diameter, while on each of the 3 400-hp. boilers are 2 4-in. Ashton safety valves all set to blow at 180 lb.

Each boiler is equipped with 2 2½-in. blowoff connections, in each line is placed a Simplex blowoff valve backed by an Everlasting valve next the boiler. The blowoff header empties into an open flume which discharges to the lake, or may empty into the hot well of the condenser.

Firemen are instructed to blow down twice in 24 hr.; there are 2 shifts, each shift blowing down once. Only one side of the boiler is blown down at a time and the alternate method is employed, thus each valve is opened once in 24 hr. for a sufficient length of time to lower the water in the boiler one gage.

The steam leads from the boiler are long radius horizontal bends which connect to a 14-in. steel header with welded flanges running the full length of the boiler room at the rear of the boilers. Each boiler lead is provided with a nonreturn angle stop valve, properly drained, and a gate valve at the header.

There are 2 4-in. auxiliary steam lines which furnish steam for the feed pumps. One of these is fed by the old boilers, the other by the new 400-hp. boilers. These headers are fed by lines leading off the main leads on the boiler side of the stop valves and are tied together at the west end of the boiler room, making an arrangement which is proof against shut-down due to an accident to the main or auxiliary header.

All steam and hot water piping is covered with 85 per cent magnesia 2 in. thick held in place by canvas and metal strips and well painted.

Feed water is taken through a 6-in. connection from the city mains, which is filtered lake water, and fed directly to the 3000-hp. open type Stilwell heater, which is carried on iron structure at the west end of the boiler room over the boiler feed pumps, giving them a suction head of 18 ft. Exhaust steam from all auxiliaries and the 2 reciprocating generating units is all available for heating the water and the average temperature is maintained at 212 deg., as shown by the Schaeffer & Budenberg recording thermometer.

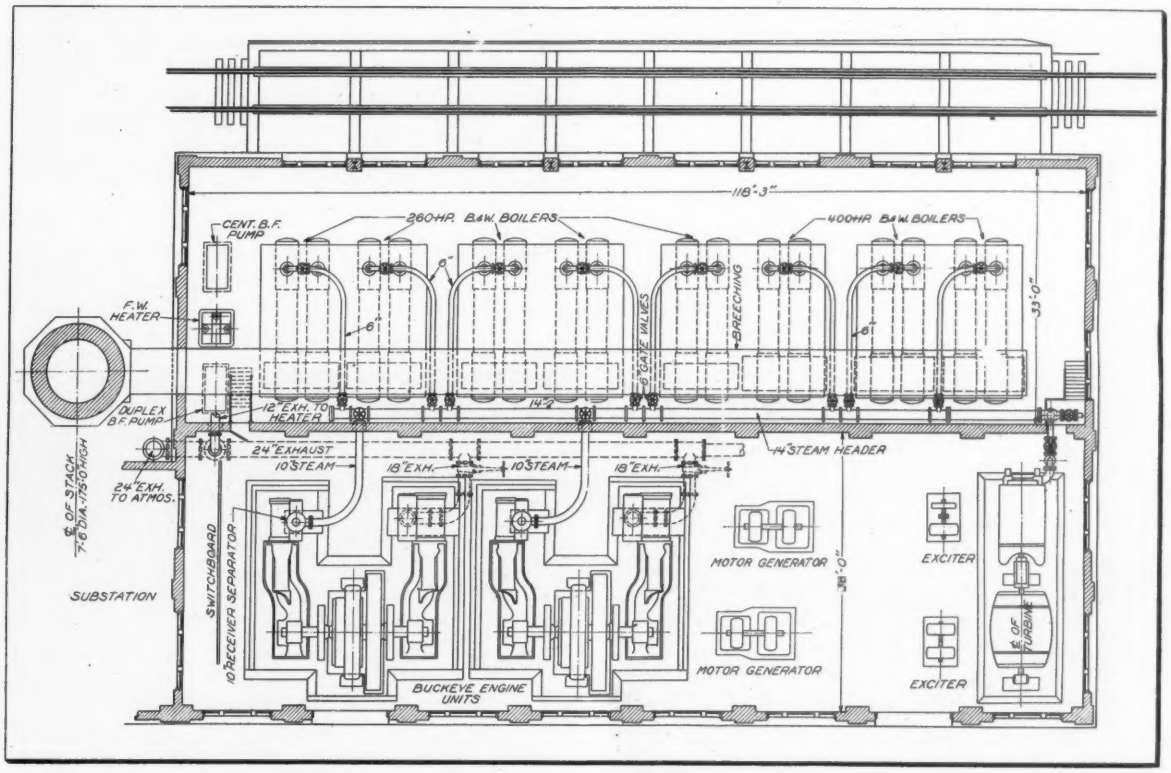


FIG. 4. GENERAL PLAN OF LAKESIDE POWER STATION

Boiler feed pumps are two in number, one, a Worthington duplex with outside packed plungers, has dimensions 14 by 8½ by 15 in.; the other is a Platt centrifugal, direct-connected to a Terry steam turbine of 35 hp. rating, run at a speed of 3000 r.p.m., giving a capacity of 225 g.p.m.

Boiler preservative is used to prevent scale in the boilers, but it has been found economical to run a Lagonda air-driven turbine cleaner through the tubes at

least once a year. Compressed air is furnished by 2 Westinghouse compressors.

In case the city water pressure should become as low as 30 lb., there is provision made by which an alarm is automatically given and piping is so arranged that the pumps can drain the city system, if need be, delivering the water to the heater and the boilers through the usual course.

The supply of feed water to the boilers is hand regulated, but each boiler is equipped with a high and low water alarm which is a guide to the firemen.

Coal is delivered to the plant in drop bottom cars on a tipple track in front of the boilers, and unloaded into a bunker the floor of which is on a level with that of the boiler room; it is hand fired to the boilers, the maximum distance of handling being 8 ft.

Ashes are removed by hand, carted outside, dumped into gondola cars and carried away by the railway company, which uses them for ballast.

Engine Room

The original equipment for generating electricity consists of 2 cross compound horizontal Buckeye engines, 24 and 42 by 36 in., operating at 123 r.p.m. noncondensing, which are direct-connected to 500-kw. type Q interpole 250 v., d.c., Westinghouse generators. These units furnish current for the ore dock but may also be used to help out the turbine in case the load becomes excessive. The load on these machines is very intermittent, on account of handling the large crab buckets at the ore docks, sometimes varying from nothing to 9000 amp. in 15 sec., yet variation in speed and voltage is not appreciable and no difficulty is experienced with sparking.

Steam piping to these units is the most simple imaginable, coming direct from the header in the boiler room through the wall in long sweeps to vertical Cochrane separators just above the stop valves to the engines.

Lubrication of the bearings is effected by a gravity system designed and installed by Chief Engineer Worley. Two supply tanks are placed on brackets near the ceiling of the engine room, part of one is shown in Fig. 6, which supply oil at about 8 lb. pressure to the bearings, where sight feed oilers are placed and set to give a steady stream upon all bearings. The oil is caught after passing through the bearings and sent through a separator to remove all water, then through a filter and by means of either air or steam forced up to the supply tanks again.

Exhaust from these engines goes to the feed water heater when needed or to atmosphere through a 24-in. multiported Cochrane back pressure valve, which gives pressure enough merely to force steam to the heater.

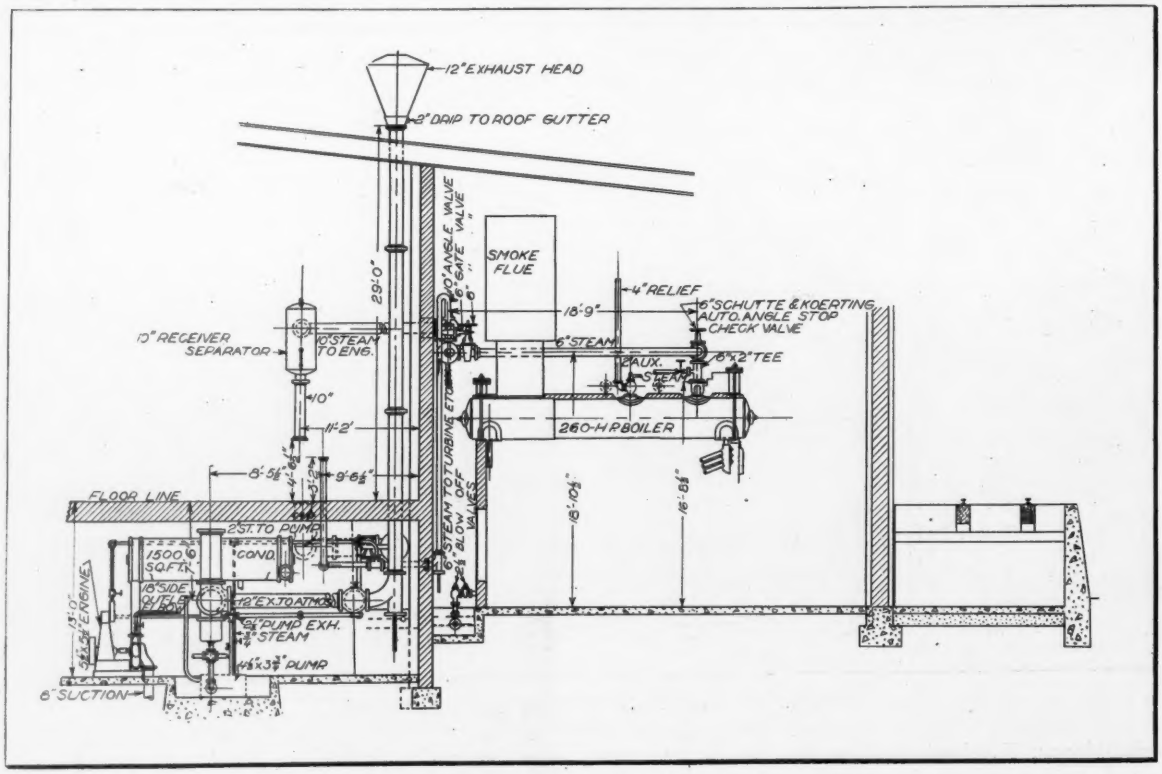


FIG. 5. ELEVATION, SHOWING STEAM AND EXHAUST PIPING

One stack serves all 8 boilers; it was built by Alphons Custodis Chimney Construction Co. with a concrete base 18 ft. square and 16 ft. deep. The stack proper is of radial brick and extends 187 ft. above the grates, with an inside diameter of 7 ft. 6 in. The draft given at the base of the stack when the boilers are all operating at normal full load is 1.1 in. of water.

Besides furnishing all steam used in this plant, the boilers supply live steam to the coal dock where coal is loaded from cars to lake freighters for lake shipment, 1400 ft. distant through a 6-in. pipe. Here it is used in 3 engines of 175, 265 and 350-hp. capacity, besides several small pumps and engines.

When the present management took charge there were added to the engine room equipment mentioned above, a turbo-generator and 2 motor generator sets, and space is still available for another turbine in case it should be needed. The unit recently installed is a Westinghouse Parsons machine of the double flow type

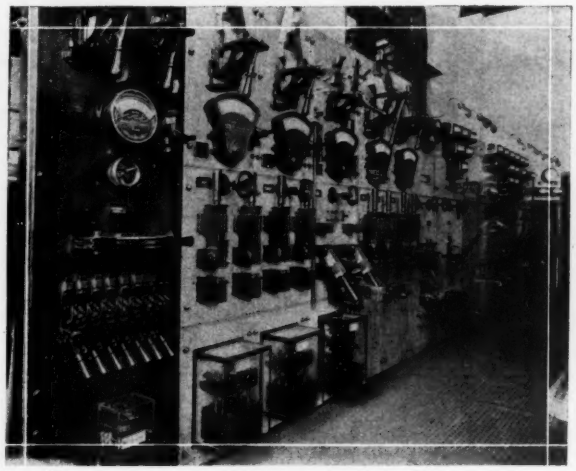


FIG. 7. SWITCHBOARD IN LAKESIDE POWER STATION

and runs at a speed of 3600 r.p.m. Its rating is 2500 kv.a., generating current at 2400 v., 60 cycles, 3 phase. Steam is supplied at 175 lb. and 100 deg. superheat.

Directly beneath the turbine is a Le Blanc condenser

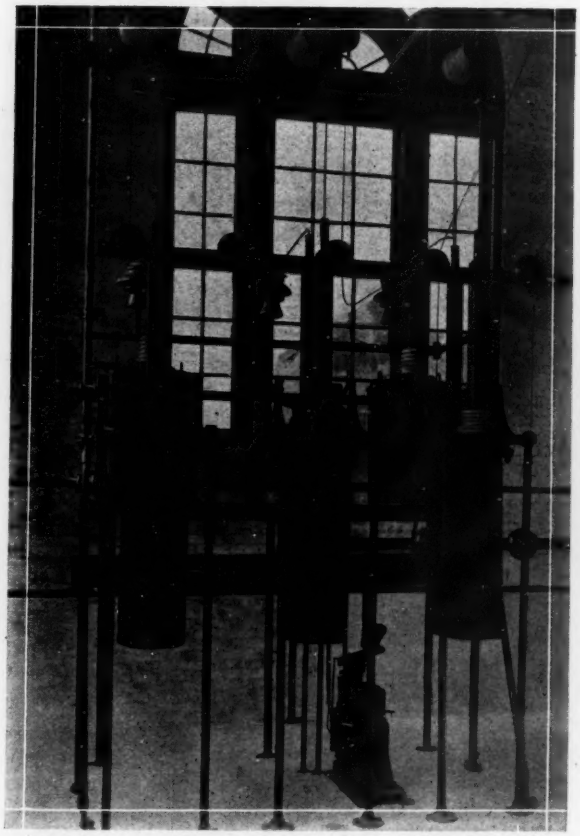


FIG. 9. HIGH TENSION SWITCH IN SUBSTATION

which maintains a vacuum on the turbine within 0.4 to 0.5 in. of the barometer. Condensing water is taken from the mouth of the Black River through a 30-in. pipe line and discharged into the lake through a 30-in. pipe and an open flume. During the summer time the average temperature of the intake water is 71 deg., while the average outlet temperature is 86 deg.; but at maximum load it reaches as high as 91 deg.

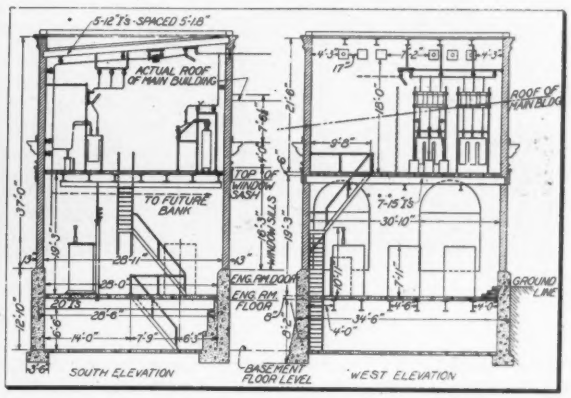


FIG. 8. ELEVATIONS OF SUBSTATION AT LAKESIDE POWER STATION

Two exciter sets, one being held as a reserve, furnish the field for this generator. One is a Crocker Wheeler 25-kw. generator giving direct current at 125 v. and driven at 3000 r.p.m. by a Terry steam turbine. The other exciter is a Westinghouse motor-generator set run at 1140 r.p.m. by a 40-hp. 2200-v., 3-phase motor, the generator being rated at 25 kw., 125 v., direct current.

In order that the turbo-generator may be used to help out the direct-current generators and vice versa, 2 motor generator sets have been installed. Number 1 is a 300-kw. unit of Allis-Chalmers make and as indicated

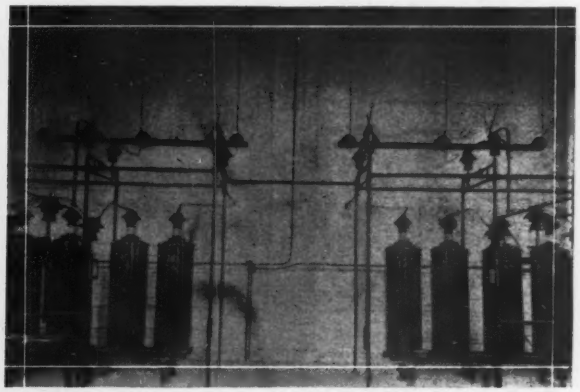


FIG. 10. LIGHTNING ARRESTERS AT LAKESIDE POWER STATION

above may be used as a synchronous motor driving a compound wound d.c. generator or a d.c. motor driving a 3-phase generator. The exciter is mounted upon the shaft and the unit runs at 600 r.p.m., being equipped with a speed limit device and a no load and overload release. The voltages are 250 d.c. and 2400 a.c. Set No. 2 is a Crocker Wheeler machine similarly equipped but has a capacity of 500 kw.

The switchboard is located at the west end of the building and has undergone considerable changes since the new equipment has been installed. Figure 7 shows the arrangement of instruments on the board, a distinctive feature of which is the location of all rheostats in the

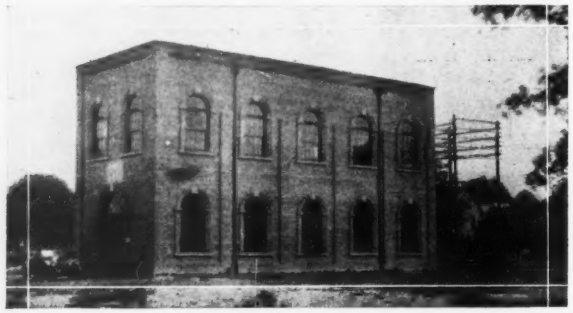


FIG. 11. ELYRIA SUBSTATION

basement below. Cables from generators to switchboard and switchboard to transformers are all run beneath the floor, where inspection and repair can easily be done.

To accommodate the step-up transformers, an addition was made to the west end of the power house which at present contains 3 Westinghouse single-phase transformers rated at 1500 kv.a., operating in delta, raising

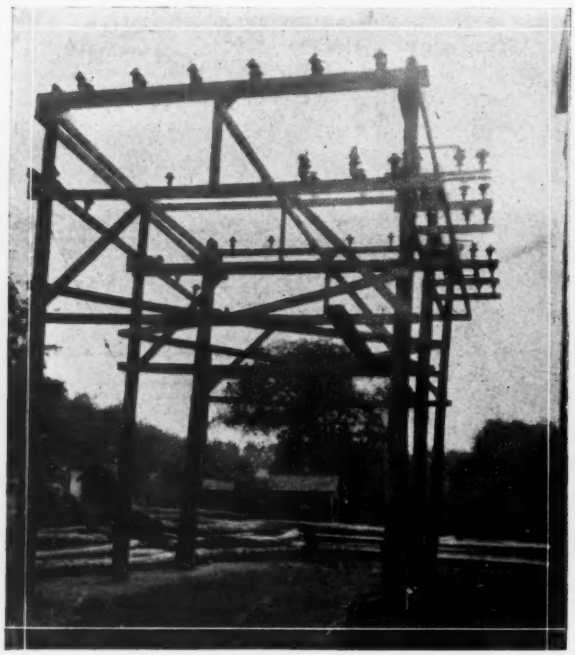


FIG. 12. HIGH TENSION SWITCHING TOWER, ELYRIA SUBSTATION

the voltage from 2400 to 22,000; but when the load on the line increases, the connections will be changed to star and with the taps which have been provided, the voltage will be boosted to 33,000. There is room for 3 more transformers on the first floor which will be added when needed. The transformers are oil insulated and water cooled, for which water is taken from the city mains.

The low tension bus-bars are in the transformer room, leads being taken from them to the transformers. The

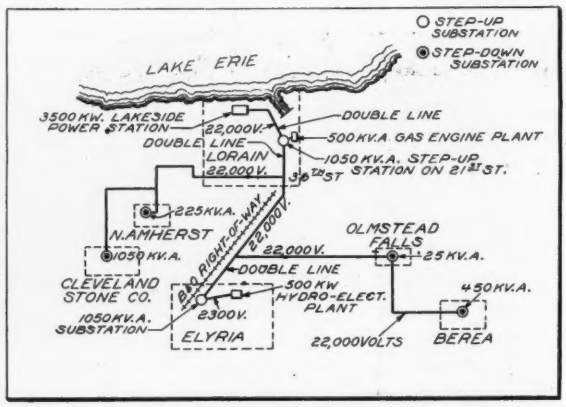


FIG. 15. MAP SHOWING STATIONS AND FEEDER LINES

high tension leads go to bus-bars on the second floor. From these, 2 circuits are taken through remote control oil breakers and choke coils to the transmission line. Electrolytic lightning arresters protect the station machinery against lightning.

TWENTY-FIRST STREET STATION

THIS PLANT was formerly owned by the Citizens Gas & Electric Co. of Lorain, but has been fitted up for a substation, reserving the former equipment as a standby in case of trouble to the lines.

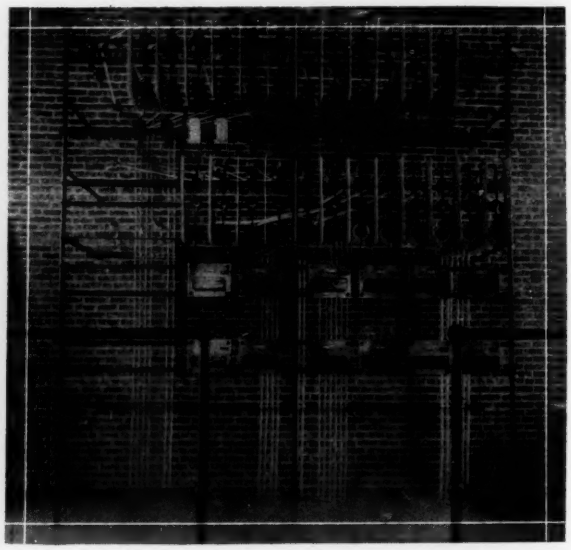


FIG. 13. FEEDER LINES AND LIGHTNING ARRESTERS IN ELYRIA SUBSTATION

There are here 2 Westinghouse 3 cylinder vertical gas engines, 18 by 22 in., rated at 280 hp. each and 1 Warren gas engine of the same capacity, each driving direct-connected Westinghouse generators of 180 kw., a.c., 3-phase, 60 cycles, 2300 v.

To furnish current for the street lights 8 50-light General Electric Co. mercury rectifiers are employed.

In the substation are 3 Westinghouse 350-kv.a. transformers with a voltage ratio of 22,000 to 2300, 60 cycles and self cooling. Lightning arresters and circuit breakers are on the second floor.

Substations at Berea and South Amherst are built on the same lines as the 21st Street substation, but the capacity at Berea is 450 kv.a., consisting of 3 150-kv.a. transformers, at South Amherst are 3 350-kv.a. transformers.

2300-v. side of the transformers with the bus bars; Nos. 2 and 3 are power feeders with 3 phase switches; No. 4 is the arc light feeder and Nos. 5, 6 and 7 control the lighting circuits. There are also 2 pedestals supporting the handles of the high tension switches located on the second floor and operated through levers and rods. The lightning arresters, choke coils and spark gaps are all on the second floor. An interesting arrangement is that of the outgoing 2300-v. lines, all protected by multiple gap lightning arresters and separated by composition barriers. Figure 13 shows the arrangement.

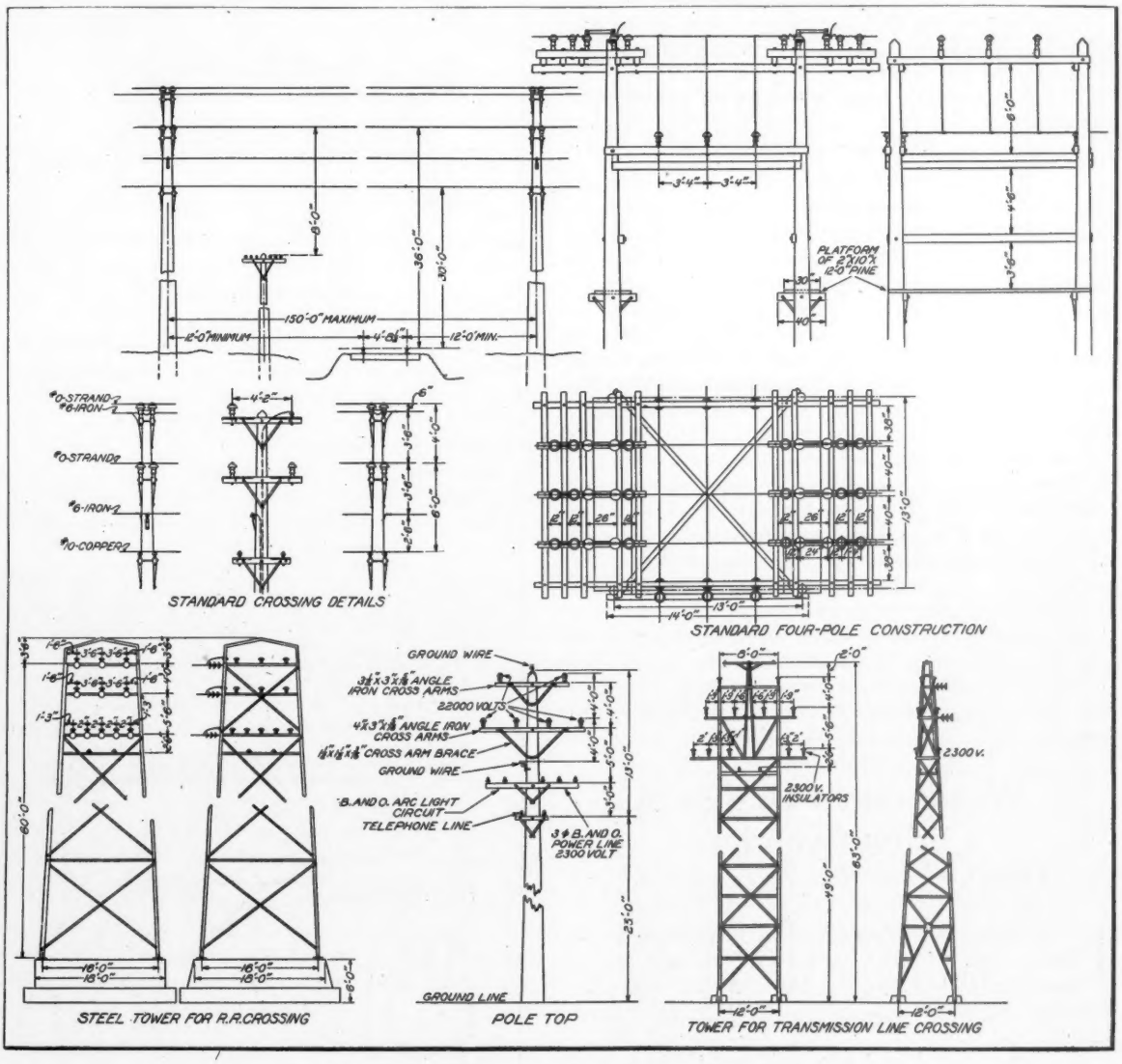


FIG. 14. SOME TYPICAL DETAILS OF LINE CONSTRUCTION

The substation at Elyria contains 3 Westinghouse single-phase transformers of 350 kv.a. each; the voltage ratio here is also 22,000 to 2300. Current for street lights is furnished by 7 Westinghouse rectifiers, each with a capacity of 50 lights. Magnetite 4-amp. arc lamps are used.

The switchboard in this station has 7 panels. Panel No. 1 contains a 3-phase switch which connects the

An idea of the line construction work may be had from Fig. 12, which shows the high-tension switching tower at Elyria Substation. This is provided with bridging and cut-out switches, making a flexible arrangement for taking care of the transmission line.

There is also a hydro plant tied in the system located in Elyria and formerly owned by the Elyria Milling & Power Co. Water is supplied by the Black River, across

which a dam is built which provides for a head of 45 ft. on 2 500-hp. Trump horizontal type water turbines. One of these is direct connected through shaft and clutches to a 200-kw. Burk 3-phase 60-cycle 2300-v. generator, a 50-kw. Burk 125-v. d.c. generator and 365-hp. Rathburn Jones gas engine all run at 257 r.p.m. A belt driven exciter runs at 700 r.p.m.

The other set is a duplicate except that the generator is of Westinghouse make.

The switchboard consists of 2 generator panels, 2-circuit a.c. feeder panel, 2 d.c. generator panels and one d.c. feeder panel. Voltmeters and ammeters are all Weston instruments, but the power factor meter, synscroscope, frequency meter and ground detector are Westinghouse instruments.

A 5-ton Northern crane serves as an aid when repairs are made.

Transmission Lines

It will be noted by referring to the map that a 22,000-v. double transmission line leaves Lakeside Power Station and is run to the 21st Street station, where step-down transformers with a capacity of 1050 kv.a. are located. From this station, a double line is carried to 36th Street, where one line branches off to Amherst and So. Amherst, the other continues to Elyria substation, a double line extends part way back from Elyria, branching off to Olmstead Falls and Berea at Berea Junction. A 2300-v. line connects the hydro electric plant in Elyria with the substation.

Pin insulators on wood cross arms and wood poles are used almost exclusively in the construction of the transmission lines, many of the details of which are shown in Fig. 14. At points where branches are taken off and all substations, switching towers are erected with cut-out and cross-over switches arranged to give the most flexible service of the line.

For courtesies extended and information given during the preparation of the above article the writer is indebted to R. E. Burger, general manager; J. B. Johnson, general superintendent, and W. C. Worley, chief engineer of the Lakeside Power Station.

Weakness in Design of Corliss Cylinders

Influence of Steam Jacket on Expansion of Cylinder. By E. R. Pearce

In the design of Corliss cylinders, there seems to have been a deal of "follow my leader," which in one type (see Fig. 1) has a very weak point that makes itself apparent when an attempt to use high superheat is made.

Cylinders like Fig. 1 give quite satisfactory results on saturated steam; but, even then, there is a certain amount of distortion. With this cylinder, one readily sees that there is one side of the cylinder wall having a width nearly equal to the bore which is jacketed with steam under the initial conditions at all times, whereas the internal temperature is forever changing so that it can readily be seen at a glance that, to keep this cylinder round is a hard proposition, at pressures of 150 lb. per sq. in., and, when 100 deg. superheat are added, the distortion is more than ever.

The worst fault is experienced when using superheat; in fact, it prevents the use of anything approaching a fair degree, as, owing to the position of the inlet steam pipe, the portion of the wall opposite it receives

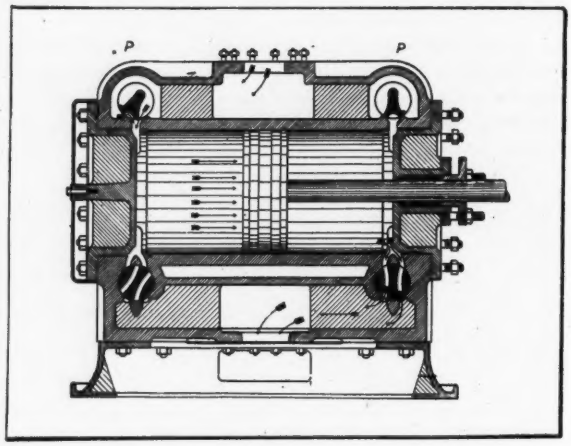


FIG. 1. TYPE OF ENGINE CYLINDER WHICH GIVES EXPANSION TROUBLES

the full effect of the high temperature, with the result that the cylinder immediately becomes egg shape in its bore at this point, besides the hump which is always more or less in evidence due to the top side only of cylinder being jacketed.

In one particular case the writer knows of, to overcome this difficulty from the use of superheat, it is

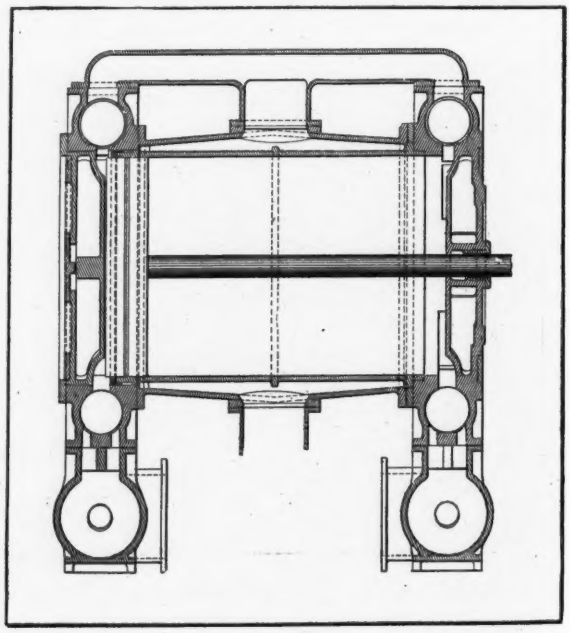


FIG. 2. PROPERLY JACKETED STEAM CYLINDER

proposed to fit a breeches pipe connecting up at P and P, where there are covers at present. By this device it is expected to be able to use a fairly high degree of superheat.

By far the best design, however, is Fig. 2, in which case the jacketing should have a space of at least 2½

in. and the inlet pipe be fitted with a deflector so that the steam does not strike directly upon the cylinder liner; the latter should be fixed rigidly at one end and be allowed to expand and contract at the other.

Quite a number of engineers doubt the advisability of jacketing cylinders, and under the old method with a small steam space, there appears to be no gain, probably due to the small volume of steam condensing practically as soon as admitted, as in many cases the jacket was supplied with a small live steam pipe and a trap; but with the main supply of steam flowing around the cylinder barrel and the jacket space having a fair receiver capacity, undoubted economy is obtained. One of the strong points in the original Wolf locomobiles was this feature. Of course, in the Wolf type any condensed steam fell back into the boiler, whereas, in the above case of jacketing with superheated steam in all probability there would be no condensation, and whatever heat was taken away by the high-pressure exhaust would be regained in the low-pressure cylinder.

Stoker Tests Under Average Operating Conditions*

RESULTS OF TESTS CONDUCTED ON MODERATE SIZE BOILERS EQUIPPED WITH TAYLOR STOKERS. BY HORACE JUDD

MUCH is being said at the present time about the high overload efficiency to be expected from the underfeed type of mechanical stoker, and the results of a number of carefully made tests have been presented to the public during the past few years, showing remarkable efficiency and economy for this type of furnace, especially for the Taylor stoker made by the American Engineering Co. of Philadelphia.

During the past year, the writer has had opportunity to make a series of evaporative tests on a 250-hp. Babcock & Wilcox boiler and a 300-hp. Flanner boiler each equipped with a 3-retort Taylor stoker. Four different kinds of coal were used and the only instructions to the firemen have been to run the furnace and boiler as usual and as if no boiler trial were in progress.

LOCATION OF PLANTS

SIX OF the boiler trials mentioned above were conducted in March, 1913, on a 250-hp. B. & W. boiler of the cross-drum type forming the boiler equipment at the Troy Laundering Co., Columbus, Ohio; and 3 of the trials were made on a Flanner boiler also of the cross-drum type, at the power plant of The Ohio State University, Columbus, Ohio. One of these 3 trials was made under about 1¼ rated load and represented the average daily output. The other 2 trials are preliminary to a series now in progress to determine the best running conditions for a 200 per cent rating with the kind and grade of coal now in use. Trial 9, especially, is given to illustrate and emphasize several important points to be considered in order to secure good combustion and efficiency. This Flanner boiler was one of a battery of 2 recently installed, each having a nominal rating of 300 hp. The boilers at both places were equipped with 3-retort Taylor stokers.

The boiler trials at the laundry were carried on under the writer's direction in co-operation with Messrs. C. C. Brown, H. B. Craft and W. O. Durbin, members of the graduating class of 1913 in Mechanical Engineering at The Ohio State University.

The coals used in the trials at the laundry were representative soft coals from the different fields lying in, or adjacent to, the Ohio fields. These coals were:

W. Va. Splint, nut, pea and slack.$2.40 per ton delivered,
Hocking, nut, pea and slack..... 1.65 per ton delivered,
Pittsburgh No. 8, nut, pea and slack ..... 2.20 per ton delivered.

CONDUCTING THE TESTS

DURING THE boiler trials (excepting Trials 8 and 9), the fireman followed the customary routine of operation, using his own judgment as to the proper thickness of fire, draft, and time of dumping ashes. The tubes were blown 2 hr. previous to each test.

Ten hours was taken as the duration of trial with readings every 15 min. excepting for the coal and water, which were weighed out as needed, and for the flue gas analyses, which were taken every half-hour from a continuously drawn sample. All such readings were totaled or averaged for the entire run and the results are to be found on the observed data and result sheets (Tables 1 and 2).

Coal samples were taken from each barrow, or bucket, of coal amounting in all to about 500 lb. per trial. These samples were analyzed for moisture, ash, and sulphur and the heating value was found by a Mahler calorimeter. In Trial 7, the ultimate analysis was also found, but for the other cases the ultimates were figured from a known average ultimate analysis from the same vein of coal. The combustible in the ash was found from a sample of the refuse and ash in the ash-pit. The percentage of unburned coal was found by the expression:

$$d = \frac{a\ c}{(1-a)\ (1-c)}\ \dagger$$

where d = per cent of unburned coal in total coal as fired,
a = per cent of ash by analysis in total coal as fired,
c = per cent of combustible in refuse from ash-pit.

The efficiency of the boiler and furnace is taken to be the heat actually absorbed by the water evaporated by 1 lb. of combustible burned, divided by the heating value of 1 lb. of combustible.

The efficiency of the boiler, furnace and grate is taken to be the heat absorbed by the water evaporated by 1 lb. of coal as fired, divided by the heating value of 1 lb. of actual coal.

*From a paper before the Ohio Society of Mechanical, Steam and Electrical Engineers.

†This formula is taken from Sohmer's Text on Fuel and was derived by Prof. of Lord, Ohio State University.

Results

THE RESULTS obtained from the trials at the laundry indicate on the whole a satisfactory performance for a boiler equipment of the smaller-sized unit when operated under overload conditions with the ordinary care of the average fireman.

The stoker is easily and rapidly cleaned if the clinker is not allowed to collect to such an extent as to prevent the proper and ultimate mixtures of air with the fuel.

The side cleaning doors bring the ash bed within easy view, and the rocking and jarring action of the extension grate in most cases will be sufficient to break up the clinker preparatory to dumping. The extension grate, formation, it was found at the laundry that the third kind of coal used (Pitts. No. 8) containing 3.6 per cent sulphur gave the most trouble from clinkering, and in addition, when the refuse was dumped or when the fan was slowed down temporarily, the sulphur fumes became almost unbearable.

The amount of unburned coal (Table 3) present in the ash-pit refuse is influenced by the rate of coal feed, the number of dumps made, and the degree to which the coal clinkers. If the coal is fed too fast, some of the coke may be pushed forward onto the dump plate where the air supply may be insufficient to burn it completely. When the refuse is allowed to accumulate too long, some of the coke may also become buried under the ash and

TABLE 1. AVERAGE DATA AND RESULTS OF EVAPORATIVE TESTS

1 Kind of furnace	3-retort Taylor Gravity Underfeed Stoker									
2 Kind of boiler	Babcock & Wilcox Cross-Drum, Water-Tube. 4-in. Tubes.						Flannery, Cross-Drum, Water-Tube. 3-in. Tubes.			
3 Grate surface	41 sq. ft.						45 sq. ft.			
4 Heating surface	Boiler 2485 sq. ft. Economizer 2040 sq. ft.						3130 sq. ft.			
5 Trial No.	1	2	3	4	5	6	7	8	9	10
6 Date	3-20-13	3-21-13	3-22-13	3-24-13	3-25-13	3-27-13	4-9-14	5-18-14	5-22-14	6-2-14
7 Duration, hr	10	10	10	10	10	10	10	10	10	10
Average Pressures.										
8 Barometer	29.1	28.58	29.74	29.08	28.89	28.94	29.46	29.82	29.32	29.55
9 Boiler gage	96.8	96.5	96.0	99.7	97.6	99.5	123.8	115.1	118.3	123.8
10 Tuyere box	1.50	1.45	1.30	1.80	2.42	1.90	1.48	1.66	2.76	.....
11 Draft over fire	.125	.09	.16	.15	.16	.19	.045	.03	.038	.023
12 Draft leaving boiler	.32	.42	.34	.31	.39	.44	.24	.25	.32	.34
13 Draft entering economizer	.71	.73	.74	.74	.89	.75	.....	.....	.....	.....
14 Draft leaving economizer	.....	.78	.81	.80	1.10	1.14	.....	.....	.....	.....
Average Temp.										
15 Fire room	88	84	78	80	87	76	71	94	96	95.5
16 Flue gas leaving boiler	745	705	664	711	710	657	450	466	485	664
17 Flue gas entering economizer	541	501	508	543	530	507	.....	.....	.....	.....
18 Flue gas leaving economizer	274	271	269	278	265	249	.....	.....	.....	.....
19 Feed water entering economizer	147	144	140	145	134	121	.....	.....	.....	.....
20 Feed water leaving economizer	170	169	180	171	165	157	.....	.....	.....	.....
21 Feed water entering boiler	162	161	170	160	152	143	54	192	69	75
Analysis of Coal as Fired.										
	W. Va. Splint		Hocking		Pitts. No. 8		W. Va. Fairmont Dis.		W. Va. Thacker Coal Field Washed	
Grade	Nut, pea, and slack						Nut and pea			
22 Moisture	4.42	4.66	9.40	11.62	6.31	3.79	6.31	3.90	2.73	6.09
23 Carbon	70.74	64.48	63.25	60.23	66.57	69.21	66.39	71.59	71.95	70.47
24 Hydrogen	5.10	4.98	5.16	5.21	5.22	5.12	5.01	4.98	4.87	5.42
25 Oxygen	11.49	11.46	17.13	18.69	12.31	10.33	13.76	9.93	8.93	12.90
26 Nitrogen	1.31	1.27	1.19	1.12	1.16	1.21	1.10	1.14	1.14	1.49
27 Sulphur	1.06	1.58	1.08	.85	3.64	3.56	2.79	2.42	3.36	1.10
28 Ash	10.30	12.33	12.19	13.90	11.10	10.57	10.95	9.94	9.75	8.62
28a Comb. in refuse	19.19	29.89	22.77	17.57	25.89	28.55	25.50	41.50	48.53	22.89
29 Unburned coal	2.73	5.94	5.34	3.44	4.30	4.70	4.21	7.83	10.17	2.80
30 Heating value, coal	12.697	12.375	11.164	10.570	12.067	12.582	12.184	12.830	13.120	12.744
31 Heating value, combustible	14.889	14.890	14.244	14.191	14.625	14.692	14.700	.....	14.980	14.950

Grate surface is considered as slant surface 1 in. above point of tuyeres.
Cross-sectional area of each retort=13 sq. ft.

when raised to its highest position, will prevent the coal bed from sliding forward when the dump plate is down and will also make it possible to feed the coal continuously during the dump period, thus keeping up the steam pressure.

The ease with which the dumping process is managed will depend largely upon the clinkering properties of the coal.

For dump periods ranging from 2 to 3 hr. (Table 3) the percentage of unburned coal passing into the ash-pit averaged 4.36 per cent for Trials 1 to 7.

For Trials 8 and 9 with 1-hr. dump periods the average unburned coal loss was 9 per cent, showing that the unburned coal loss varied about inversely as the length of the dump interval.

While the presence of sulphur in the coal may not have, as some claim, any great effect on the clinker clinker. The clinker, if easily fused, may run down and envelop some of the unconsumed coal.

Coal feed is uniform and positive, and under control through the speed regulator on the fan engine. The rate of feed can be approximately determined by noting the revolutions of the upper rams, since each ram plunger forms a displacement meter and for the same kind and grade of coal will discharge nearly the same weight of coal per revolution of plunger. For the grade used in Trials 1 to 7 inclusive, the amount fed per retort per revolution of the stoker shaft ranged from 14.8 to 16.1 lb. with an average of 15.7 lb., which is about a constant for the Taylor stoker.

Close air regulation is also possible. The proper amount of air is supplied entirely by means of the forced draft fan. For a given coal it is only necessary to determine the required amount of draft over the fire to

secure good combustion conditions as shown by the flue gas analysis. This is chiefly a matter of obtaining the right speed ratio between the fan engine and the stoker shaft. When the proper air supply is secured, it can be so maintained, independent to some extent of the rate of combustion, since the coal feed and air supply are both controlled by the fan engine governor. Occasionally the fireman may find it necessary in maintaining a uniform draft over the fire to adjust the damper in the air pipe leading to the windbox; but, generally speaking, most of the regulation may be made at the flue damper. The tuyere-box pressure should remain nearly constant for a given rate of combustion and draft over the fire, increasing with a higher rate of coal feed. Should it be necessary to increase the tuyere-box pressure to get the proper draft over the fire, other conditions remaining constant, it would indicate that the fire bed was becoming clogged and that the air supply was restricted by clinker formation.

During the tests at the laundry, owing to the extremely variable load, the draft over the fire showed a wide instantaneous variation ranging from a pressure slightly above zero to as much as 0.5-in. suction, though the average results are fairly uniform, varying from 0.09 to 0.19 in. This could be improved by placing the induced draft fan at the economizer and the stoker fan under the same speed control which would tend to maintain a more evenly balanced draft.

At the University the fireman was aided in the management of the stoker by a G. E. steam flow meter located nearby, which indicated the output of the boiler, and also by a gage showing the amount of draft carried over the fire. For Trial 7 this gage varied from zero to 0.15 in. suction with an average of 0.045 in.

TABLE 3. DUMP PERIODS

Trial No.	Kind of coal	Interval between dumps	Per cent unburned coal	Per cent sulphur
1	W. Va. Splint	2.5 hr.	2.73	1.06
2	W. Va. Splint	2.5 hr.	5.94	1.58
			av. 4.34	av. 1.32
3	Hocking	2 hr.	5.34	1.08
4	Hocking	2 hr.	3.44	.85
			av. 4.39	av. .97
5	Pitts. No. 8	3 hr.	4.30	3.64
6	Pitts. No. 8	3 hr.	4.70	3.56
			av. 4.50	av. 3.60
7	W. Va., Fairmont District	2.4 hr.	4.21	2.79
8	W. Va., Fairmont District	1 hr.	7.83	2.42
9	W. Va., Thacker Coal Field (washed)	1 hr.	10.17	3.36
10	Field N P	2.5 hr.	2.80	1.10

TABLE 2. AVERAGE DATA AND RESULTS OF EVAPORATED TESTS

Trial Number	1	2	3	4	5	6	7	8	9	10
Coal per hr.										
32 Fired per hr	1612	1576	1595	1943	1825	1747	1601	2076	2528	2476
33 Per sq. ft. grate	49.1	47.8	48.4	58.9	55.3	53.1	48.5	46.0	56.2	55.1
34 Combustible burned per hr	1338	1230	1168	1397	1441	1425	1265	.....	1988	2050
35 Rev. per hr., stoker crank shaft	36.0	32.8	36.3	41.0	38.4	36.8	38.5	41.7	51.8	53.9
36 Coal per retort per rev	15.0	16.1	14.8	15.8	15.9	15.9	15.8	16.6	17.3	15.3
37 Coal per hr. per boiler hp	3.78	3.72	4.31	4.73	4.19	4.21	4.06	3.96	4.34	3.9
Water per hr.										
38 Fed to boiler lb.	13723	13657	12054	13280	13966	13255	11399	.....	16962	185311
39 Quality of steam	98.5	97.7	98.2	97.9	97.9	97.8	99.0	99.0	99.4	99.32
40 Equiv. dry steam lb.	13516	13334	11834	12995	13668	12964	11279	.....	16865	184539
41 Factor of evap	1.091	1.092	1.083	1.093	1.101	1.110	1.206	.....	1.192	1.185
42 Equiv. evap. from and at 212 deg. lb.	14741	14590	12808	14204	15049	14390	13603	.....	20105	218770
43 Equiv. evap. per sq. ft. heating surface	5.90	5.84	5.12	5.68	6.02	5.76	4.33	.....	6.38	.....
43a Cost per 1000 lb. equiv. evap., cents	13.12	12.96	10.27	11.29	13.36	13.34	.....	.....	.....	.....
Horsepower.										
44 Developed	426	423	371	411	436	415	394	524	583	635
45 Builders' rating	.....	.....	248.5	.....	.....	.....	313	.....	.....	313
46 Per cent builders' rating	172	171	149	165	176	167	126	167	186	203
Economic Results.										
47 Water fed per lb. actual coal	8.52	8.67	7.56	6.84	7.66	7.59	7.13	.....	6.71	7.55
48 Equiv. evap. per lb. actual coal	9.15	9.26	8.03	7.31	8.25	8.24	8.49	8.71	7.96	8.95
49 Equiv. evap. per lb. combustible burned	110.2	11.86	10.97	10.17	10.45	10.09	10.75	.....	10.11	10.68
Efficiency.										
50 Boiler and Furnace	71.8	77.3	74.7	69.4	69.3	66.7	71.0	.....	66.0	69.2
51 Boiler, furnace, and grate	69.9	72.5	69.9	67.1	66.3	63.5	67.6	65.8	59.0	68.1
Flue Gas per Cent by Vol.										
52 Carbon dioxide	15.20	14.20	13.50	14.70	12.40	12.10	10.84	12.95	11.97	14.60
53 Oxygen	3.46	5.22	5.50	2.30	5.51	5.20	8.32	5.33	4.52	2.70
54 Carbon monoxide	.39	.40	.09	.70	.05	.15	.13	.40	.91	.25
55 Per cent excess air	19.4	33.6	34.9	12.0	34.4	31.6	65.2	33.0	26.3	.....
56 Air req. per lb. coal	8.9	8.6	8.2	7.6	8.3	9.0	8.5	.....	8.5	.....
Heat Losses, Per Cent.										
57 Latent heat	3.54	3.53	4.17	4.43	3.85	3.61	3.66	3.33	3.10	3.84
58 Carbon monoxide	1.38	1.40	.36	2.67	.24	.66	.63	1.61	3.53	1.29
59 Products of combustion	12.71	11.95	11.69	12.69	11.99	11.42	7.77	6.92	6.91	11.19
60 Excess air	2.11	3.42	3.54	1.28	3.51	3.13	3.99	2.02	1.57	1.37
61 Radiation, etc	7.19	1.25	5.65	8.39	9.75	12.93	12.17	12.48	15.82	11.41
62 Per cent black smoke by chart	13.1	17.01	5.0	15.7	12.7	13.8	.....	.....	.....	.....

This close air regulation, together with the fact that the air in passing through the tuyeres is preheated and also because of the fairly large combustion chamber, will result in a high furnace temperature; consequently better combustion is secured with smokeless conditions.

(To be continued.)

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

The Why and How of Induction Motor's Revolving Field

A Simple Description of an Otherwise Complicated Theory; Operation of Induction Motor Simplified. By A. L. Temple

WHY the rotor of an induction motor made up of a number of copper bars short-circuited on end rings, revolves in the presence of a magnetic field and possesses a powerful torque with no electrical connection to the supply circuit, is usually explained by the statement that the induction motor has a revolving field and that the rotor is dragged around by it. The why and how of the revolving field has been the subject of considerable discussion and most writers on the subject soar into highly technical language and mathematics in such a way as to make the revolving field something of a mystery to the man who is not blessed with an intimate knowledge of the theory of the electric circuit.

If the reader can forget that there is any mystery at all about the induction motor and will follow carefully what is said here, it is believed that a mental picture of the fundamentals of 3-phase circuits can be

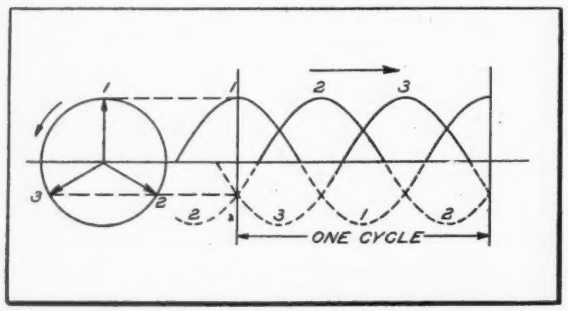


FIG. 1. RELATION OF 3-PHASE CURRENTS

secured and the reason why the induction motor has a revolving field made plain. For the purpose of establishing this picture, the writer has prepared some diagrams, a study of which has made this matter plain in his own mind. While these diagrams may at first sight appear complicated, they need not be approached in this spirit, for they can be understood by any man who will read and follow out the drawings.

First of all, it is to be remembered that in a 3-phase circuit of 3 wires, there are in reality 3 currents, each passing through values of a positive maximum to a negative maximum and back again at regular intervals, and each one of these values for any one current following similar values of the other currents at equal intervals of time, namely 120 electrical degrees; that is to say, the positive maximum of one current follows the positive maximum of the one just ahead by 120 electrical degrees, and likewise all other changes of current values from the maximum in a positive direction through zero to a maximum in a negative direction and back through zero to a maximum in a positive direction, take place during what is known as one cycle or 360 electrical time degrees. For a 60-cycle circuit this action takes place

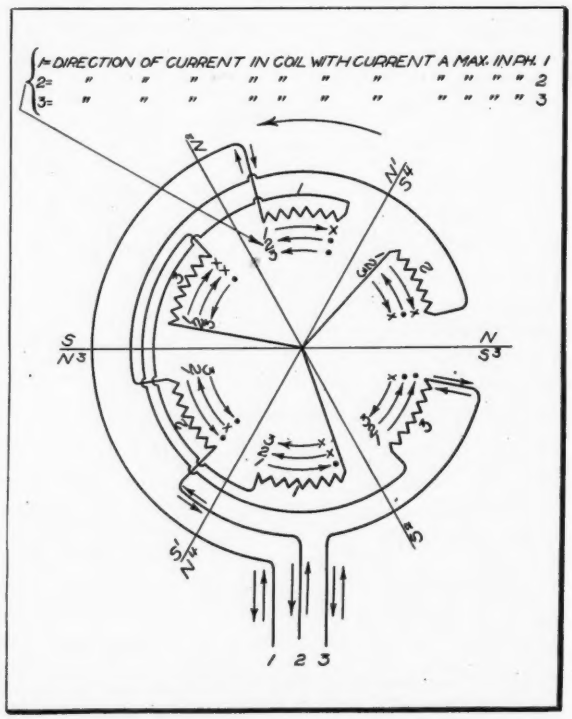


FIG. 2. WINDING DIAGRAM OF A 2-POLE, 3-PHASE MACHINE

in 1/60 sec.; that is, during this time the 3 currents pass through all values as mentioned above, from positive to negative, the first being 120 deg. ahead of the second and the second 120 deg. ahead of the third.

In Fig. 1, the way these 3 currents change in value and their relation to each other is shown for 1 cycle.

Here it will be noted that the changes of positive values of all phases are indicated by the full line of the sine waves and changes of negative values by dotted lines, and when current No. 1 is largest in a positive direction, current No. 2 is ½ this value in a negative direction, and as current No. 1 decreases (proceeding in the direction of the arrow) current No. 3 increases in a negative direction and current No. 2 decreases in a negative direction. This process continues until current No. 3 reaches its greatest negative value, when currents 1 and 2 are equal and ½ the value of current 3. As current No. 1 decreases from positive maximum to zero, current No. 2 continues to decrease, passes through zero and continues to increase in a positive direction until, when current 1 is zero, the currents No. 2 and 3 are equal, but one positive and the other negative. One-quarter of a cycle has thus been passed, the remainder being covered in precisely the same way as regards relationship of currents. When 1 current of the 3 is a maximum, the other 2 are equal and of opposite value. When 1 current has a zero value the other 2 are equal, but 1 positive and the other negative. These are points to remember as they are mentioned when referring to poles of induction motor later.

Referring now to the winding of the stator of the induction motor, as shown in Fig. 2 for a 2-pole machine, the windings are arranged and connected in groups, 1 group for each phase under each pole so that any pole embraces 3 groups of coils for a 3-phase machine. That is, 2-pole machine will have 3 groups of coils for a north and 3 groups of coils for a south pole, and each coil represents a phase and carries current Nos. 1, 2 and 3 respectively, as referred to in the diagram and known as the "phase currents."

When the current in phase No. 1 is a positive maximum, current may be considered to flow into the top winding, then down to the opposite winding of phase 1 and to the point where the 3 sets of windings are joined. Here the current splits into 2 equal currents, which flow through phases 2 and 3 and from the arrows marked 1, 2 and 3, it is plain that the currents in all windings below a horizontal line through the center of a section of the stator flow in 1 direction, say up through the paper as is indicated by the dots at the end of the arrows shown in the diagram under any coil while all above flow down through the paper, as indicated by the cross-marks. Since the current in phase 1 is a maximum, the currents in phases 2 and 3 are equal, so that the total current strength above and below the horizontal line is the same and the poles of the field produced are at the end of such a horizontal line.

When phase 1 current begins to decrease toward zero, the currents 2 and 3 also change. Current 3 increases and current 2 decreases; thus the field strength of phase 3 increases and that of phase 2 decreases, which pushes the point of maximum field strength up at the right and down at the left of the horizontal line already mentioned. When the current in phase 2 has become zero, then that in phase 3 is equal to phase 1, but in opposite direction, and the poles are formed along a line through the middle of phase 2, since the field strength then balances about this line as an axis. As phase 2 passes the zero value in a positive direction, the current in phase 3 increases and tends to push the poles further around in the counter-clock-wise direction until when current in No. 2 winding is a maximum in a positive direction, the poles are located as shown at N′ S′, or between the windings of phase 2 and 1, the strength of which is equal as in the case of phases 2 and 3, when current in phase 1 was a maximum. As current in phase 3 passes through its negative maximum value, toward zero, current in phase 2 is increasing toward a positive maximum and tends to push the position of the poles into the field of phase 1, which is then at its weakest value, since the current is passing from a positive value through zero to a negative value. Then with current in phase 2 at its maximum positive value, the poles have a position as at N^2 S^2 with strength of phases 1 and 3 equal.

Thus, when current in any 1 phase is a maximum, the currents in the 2 other phases are equal, and a line showing the location of the poles of the field takes a position perpendicular to the axis of the phase carrying the maximum current, which is for the 2-pole machine as shown in Fig. 2, midway between the other 2 coils. At other values of any current in any phase, there is a shifting of the axis of the field away from the winding carrying the largest of the 2 other currents. When the current value of any phase has changed from a maximum in 1 direction to a maximum in another direction, the field has made ½ of a revolution or the north pole is in the original position of the south pole and vice versa for a 2-pole motor as shown. That is, for a 2-pole motor, the field makes 1 revolution per cycle, and for any other number of poles, the number of field revolutions per minute is equal to 60 times the number of cycles, divided by ½ the number of poles.

A revolving field set up as already explained through induction similar to the action of the windings of a transformer, drags the rotor of the induction motor around at nearly the field speed, the difference in speed being known as the motor slip, which difference depends upon the load on the motor.

Setting the Air Gap

RESULTS OF NONUNIFORM AIR GAP; GAP MEASUREMENT TAKEN WITH GRADUATED WEDGES. BY GORDON FOX

SETTING the air gap of a large direct-current machine or alternator is of course a purely mechanical operation, yet its accurate performance is necessary to insure satisfactory electrical working.

First to be considered is the proper location of rotor and stator; second, the method of best and most easily securing this condition. Electrical performance alone would always dictate an exact central location of the rotor or armature. It is the general custom, however, to locate the rotor in large machines slightly above center in order that the consequent unbalanced magnetic pull may be in an upward direction, thus lifting the weight of the rotor in part from the bearings. The amount of eccentricity advisable depends upon several factors, the weight of the rotor, strength of the stator or field frame and the electrical characteristics of the machine. A very heavy rotor or armature will in general be placed relatively higher than a light one. If the dis-

tance between bearings be long or if there be a flywheel between bearings next the armature, then the lifting effect should be made as great as mechanical strength of the stator and as the electrical characteristics will allow.

It must be realized, of course, that an upward pull on the rotor causes a downward pull on the stator or field which tends to distort it and make it elliptical. Direct-current machines usually have a heavy field frame and are capable of standing a heavy magnetic pull. Mechanical strength is, therefore, not usually the limiting factor for this type of machine. Alternators often have comparatively light stator frames. This is particularly the case for stators of slow speed machines of small capacity, where a large diameter is required because of the large number of field poles necessary, yet a narrow stacking will suffice because of limited rating. These stators are easily distorted and are not capable of supporting very much of the rotor weight. The writer recalls an experience in which such an alternator was being run while mounted on a test shaft which caused the stator to be very slightly eccentric. As the poles

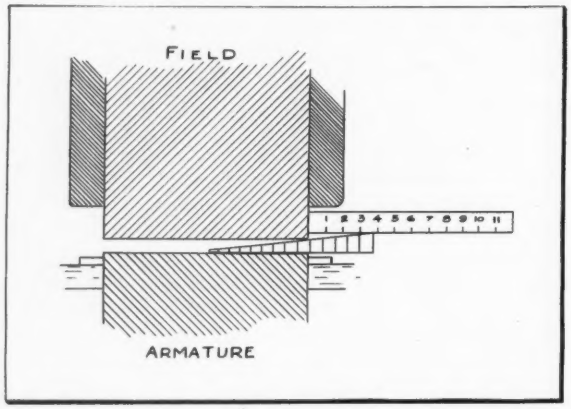


FIG. 1. METHOD OF APPLYING WEDGE TO AIR GAP

closest to the stator would revolve, it was possible to detect the distortion of the stator, each successive portion being drawn inward by the unbalanced pull, causing a sort of wave of distortion in the frame.

The third consideration of location is the effect of eccentricity upon electrical performance. There will naturally be unbalanced voltages set up in a machine in which the rotor is not central. In the case of most machines, this is not a serious matter, but in a few it is of importance. Direct-current machines provided with equalizers will ordinarily be little affected. Wave wound machines also are largely immune to ill effects from eccentricity due to the distributed coils in the circuits. Lap wound machines without equalizers may sometimes be caused to spark if the eccentricity is too great.

In most alternators, the coils are so arranged that each path or circuit includes coils located over the entire stator circumference, however, in occasional machines of low voltage ratings there may be paths in parallel located entirely in separate portions of the stator circumference. In the latter case, eccentricity will cause unbalanced voltages in the parallel circuits so that cross currents will flow. These have no damaging effects except extra loss and useless heating.

In general it may be said that the armatures or rotors of large machines should be located from $^1/_{32}$ to $^3/_{32}$ in. above center, the exact amount being governed by the factors above mentioned.

Horizontally, stator and rotor should line up exactly. In almost all cases the stator stacking or field pole width is the same as the armature or rotor stacking length. The 2 magnetic circuits should be exactly opposite as shown in Fig. 1; if they are not, there will be an end pull or thrust due to the magnetic tendency of the parts to line up opposite one another. In machines permitting end play, it is best so to adjust the bearings or frames that when the field and armature or stator and rotor are opposite one another, then the shaft is in about mid position in its end travel.

This tendency to alinement is sometimes the cause of end pounding. If the shaft of a machine is not level, there will be a tendency, due to gravity, for it to run against the lower bearing. Opposing this is the magnetic force. As a consequence of the 2 forces, the shaft is likely to overtravel upward, due to magnetic attraction, then violently return, striking an end blow on the lower bearing, bouncing back and repeating.

There is but one class of machines in which armature and field should not necessarily be exactly opposite; this is in the case of vertical machines; here it is advis-

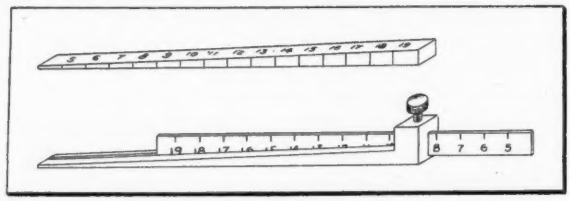


FIG. 2. WEDGE USED IN MEASUREMENT OF AIR GAP

able if possible to set the frame a little high with respect to the revolving part so that the magnetic tendency will be upwards and the bearings will be relieved.

The proper location of the parts being decided, the next question is the easiest method of making them line up. We will consider the case of horizontal machines provided with sole plates since the great majority of large machines are of this type. The position of the rotor is fixed in most cases by the engine, one step in lining up the engine being to secure an exact level to the shaft and a right angle with the cylinder center line. It is thus a case of shifting the field or stator to the proper position with respect to the revolving part. This is done by moving the sole plates. In some instances, sole plates are furnished which are adjustable, in that they will allow the frame to be shifted horizontally in either direction and are provided with screws to do the shifting. For such cases, the principle is the same as for simple solid sole plates, but the process is a little easier.

The foundation of concrete is prepared in advance and the foundation bolts for the sole plates are provided, these being set in boxes or pipes to allow some movement when locating them. Right here it may well be suggested that it is good practice to allow plenty of movement at this point. The engine must be located before the generator is set. Engine experts are likely to locate the engine so that most of the play is taken up around their foundation bolts. Then, in lining up the generator,

it becomes necessary to chip concrete to gain a little movement. Since the generator is lined up last, it should be allowed greater movement space. The concrete level upon which the sole plates rest, is made about an inch lower than the bottom of the sole plates. Forged strap iron wedges are then used to hold up the sole plates and to adjust their height. Cast-iron wedges are sometimes used, but the time wasted through their breakage will more than pay for a good set of forged wedges. The wedges are but temporary supports. After the machine is alined, a dam is built up from the concrete around the sole plates and grout is poured in and under the plates, making a permanent job. The wedges are left in until this sets, or permanently if difficult to remove.

Before lining up the machine, in fact, before placing it upon the sole plates, it is well to insert a few shims of sheet iron under the feet. This is to allow future realinement. As the bearings wear, it may be desired to lower the frame. This is a very difficult matter unless shims have been provided when the machine is first installed.

In alining the machine, the first point is to get the frame and rotor opposite. In doing this, the place to take observations is directly opposite the feet, since otherwise a slight tilting of the frame will lead to erroneous conclusions. In securing oppositon for the magnetic circuit, it is well to note whether there will be any end play to the shaft and to govern the setting for mid position. When opposition is secured the next step is to determine the amount of air gap. This can be found by measuring at both sides of top and bottom and taking the average. Any tilting or wrong vertical position is here eliminated. Knowing the average gap, figure the proper amount at the top and bottom from the allowance to be made for lifting as previously mentioned. Now adjust the wedges so that the top will meet these figures on both sides within, say, $^1/_{64}$ in. difference on the 2 sides. If the parts are opposite at the feet and the top air gap is the same on both sides, the top is sure to come opposite the rotor at that point. Next, shift the machine sidewise to even up the gap on the sides, then check all around and the job is done.

A few detail suggestions may be in order. In measuring always measure from iron to iron on top of a tooth taking care to clear wedges and bands. It simplifies matters to mark the measurements with chalk on the machine at the various points so that positions may be referred to at a glance. Don't rub out the first reading, but put another under it so it will be seen which direction the movement is taking.

The simplest and most accurate measuring means is the air gap wedge. Two types are shown in Fig. 2. The upper cut is simply a machined wedge with a taper on one side $^1/_{32}$ in. to the inch. It is marked off every ½ in. in 64ths, the best range being about as shown. The wedge should not be more than ½ in. across, since it is then easier to get into small clearances. The method of using this type of wedge is shown in Fig. 1, a scale being used to measure the amount projecting. The wedge is removed and the measurement then taken back from the end and the corresponding wedge reading noted. The wedge shown in the lower cut of Fig. 2 simplifies matters and is the quickest to use if much work is to be done, but is a little harder to make. With this wedge, a scale is provided furnished with a set screw. The wedge is inserted in the gap, the scale slid against the pole face or stator stacking and set. The wedge is then withdrawn and the gap value read directly on the scale.

Public Service Electric Rates

WHAT IS A FAIR BASIS FOR CHARGES FOR LIGHTING AND POWER? HOW SHALL SUCH CHARGES BE CONTROLLED? BY H. W. ASHLEY

THE National Electric Light Association held its 37th annual meeting at Philadelphia during the first week of last June.

This organization claims a membership of 15,000 corporations engaged in selling electric current for heat, light and power to the public. They represent capital in excess of $3,000,000,000 and collect annually operating revenues of more than $500,000,000.

Attendance of 4000 delegates testifies to the lively interest and keen activity of those who make up its membership, all the states from Maine to California being represented.

Associations so numerous in membership and so extensive in territory have heretofore been confined to religious and political interests. It is not trifling then to inquire by what common interest and for what commercial advantage these men were induced in so great numbers to undertake the expense and inconvenience incident to this meeting.

An extended synopsis of the proceedings and committee reports were published in the Electrical World of June 6, 1914.

The discussion of the reports of committees on rate schedules and the relations of the Public Service Corporation to the Public Service Commission occupied the major part of the session.

The debate centered about the questions involved in the basis for making charges for electricity—the only commodity which all of its members are chartered to sell to the public.

Two principles were emphasized: First, that the members were Public Service Corporations—like railroads, telegraph and gas companies—and therefore subject to government regulations; second, that the basis of all rates for current should be "the value of the service" to the customer and that the measure of this value should be determined by "the amount for which the user could supply himself."

This language recalls the phraseology employed by the railroad manager 30 yr. ago: What "the shipper is able to pay" and "what the traffic will bear"—and the inquiry at once presents itself: "May public service corporations impose upon customers charges based upon this principle?"

Thirty years ago, railroads charged the local, small, or helpless shipper of freight perhaps twice as much

for the same service—under similar circumstances and conditions—as they charged others located at common or competitive points; and 20 yr. ago afforded the privileged few a similar advantage by the concealed method of paying rebate to these who offered an attractive quantity or whose location enjoyed transportation competition.

These abuses developed the state and federal statutes by which the right and privilege of corporations organized to perform a public service are now limited and circumscribed.

Such corporations are now precluded by their charters from exercising the privileges of commercial industrial companies, either by selecting their customers or by making different prices or rates for the same commodity under like circumstances and conditions.

These 15,000 utility companies transport and sell electricity. Their only product is coal converted in form but potentially unchanged. The Federal courts have announced 3 opinions, never reversed or modified and accepted everywhere and always as the principles upon which the public may rely when charters are issued to public service corporations. These decisions buttress the public against those special privileges which for 30 yr. were employed by railroad companies and which created the colossal fortunes of the 19th century, those pyramids of wealth which, for a brief period, menaced the perpetuity of our individual liberty and our free institutions.

In "Western Union vs. McCall Publishing Co." (181 U. S. 92,-100), words (transported by electric energy) were sold to the Nebraska State Journal for $1.50 per 100, while the same telegraph company charged the Lincoln Daily Call, in the same city, $5 per 100 for a like, but smaller, and contemporaneous service. The Federal Supreme Court laid down this principle: The Telegraph Co. is "endowed by the State with some of its sovereign powers. As a consequence of this, all individuals have equal rights in respect both to service and charges; that the principle of equality does forbid any difference in charge which is not based upon a difference in service; and even when based on a difference in service must have some reasonable relation to the amount of difference and cannot be so great as to produce an unjust discrimination."

The other 2 cases are equally fundamental and never reversed or modified. The Federal Court in 31 Reporter 689 holds that discrimination was not justified because a lower rate was necessary to secure the business as against a competitive carrier; and (225 U. S. 326) that differences in rates for the same commodity must be justified by substantial differences in the cost of the service rendered.

The primary principles of law then incontrovertibly require that the tolls of all public service companies (all which are endowed by the State with some of its sovereign powers), must be reasonable in amount and that the rate or charge made by such corporations must be the same to every customer for the same commodity, unless the circumstances and conditions make a material difference in the cost of the service rendered; and that they are forbidden to impose charges which are based either on the quantity purchased, on competition, on what the customer may prefer to pay rather than be deprived of the service, on "the value of the service to the user" or on "what the traffic will bear."

In Boston, New York, Chicago and generally throughout the United States, the public service companies which sell electric light and power, publish rate schedules which offer current for prices varying from 1 cent to 12 cents per kw.-hr. The individual who must either use its product or burn gas, oil or candles, is charged 12 cents, while the department store, the manufacturer or apartment owner may buy for 1, 2 or 3 cents, in proportion to the (potential) probability that he will install a private operation. The "value" of current to the user apparently depends then not upon the nature of his service—whether light or power—but solely upon the amount of his consumption and whether he is willing or able to create the competition of a private plant. The householder can never do so economically, therefore, he pays the maximum price; the manufacturer may make his own current, consequently he may buy for whatever rate it would cost to produce by machinery of his own.

The fundamental inquiry now presents itself: Are these rates "based upon a difference in service?" Does the difference in the cost of service to wholesale and retail consumers justify the difference in the rates generally charged by central stations.

Every kilowatt developed simultaneously by a central station requires its pro-rata proportion of the machinery of production and transportation; an operation of 100,-000 kw. requires 10 times as much machinery and 10 times as much wire for transportation as an operation of 10,000 kw. If, therefore, the current is delivered during the same hours, if the peaks wholly or partly coincide, then every kilowatt is fairly chargeable with its percentage proportion of all the expenses, including amortization, interest and taxes, as well as engine room cost of production.

Since every kilowatt costs the same amount at the switchboard and since the executive, soliciting and expert service is employed primarily to secure and to retain the wholesale light and power customers and only incidentally for the advantage of the householder, then manifestly the only cost difference of serving the domestic (retail), and the manufacturer, the department store or the apartment house (wholesale), user is limited to the difference in the cost of distribution, reading meters and clerical service.

If we make 100 the unit of production or power house cost, then the entire expense of conducting the business of 2 typical central stations—one of 5000 and another of 50,000 kw., analyzed by Henry D. Jackson, develops these percentages:

Operation	100
Office, executive soliciting and experts	101
Distribution	73
Taxes	68.2
Maintenance and depreciation	125.7

About 15 per cent of the entire cost of conducting the business of a central station is then chargeable to the expenses incident to the distribution of the current. If the entire cost of the energy sold is 4 cents per kw.-hr., then the entire cost of distribution is about 6 mills per kw.-hr. Furthermore, if the switchboard cost, not including maintenance and depreciation, is 1 cent per kw.-

hr., these percentages prove that the expense of its transportation to the customer does not exceed 6 mills per kw.-hr. Inasmuch as turbine engine builders readily guarantee, with coal at $3 a ton, a manufacturing cost (not including depreciation) of less than 1 cent per kw.-hr., the entire cost of its distribution cannot exceed 6 mills, and the relative cost of this expense to the wholesale and retail consumer may, because of its insignificance, be entirely ignored.

That the cost of reading meters and making and collecting accounts is greater for 6000 household than for 100 wholesale users it is necessary to concede. Analysis demonstrates, however, that in operations of 5000 kw., or more, the entire cost of all the work involved in compiling and collecting accounts does not exceed 5 mills per kw.-hr. sold. If, then, the current costs 4 cents per kw.-hr., the entire cost of the accounting is approximately 8 per cent of the gross expenses of the business.

If, then, the wholesale customer is relieved from paying any part whatever of the transportation and accounting expenses and required to pay only his full proportion of the operating, executive, taxes and maintenance and depreciation costs, his rate should (on cost of service basis), be less than that of the domestic consumer by about 23 per cent (15 per cent for transportation and 8 per cent for accounting); or—on a basis of current cost of 4 cents per kw.-hr., about 1 cent less than the household customer.

If, therefore, the schedules of prices charged in these cities varies from 1 to 12 cents per kw.-hr., or as much as 1200 per cent—and the entire cost of service expended in distribution and accounting does not exceed 1 cent, or 23 per cent of the entire cost of current sold, then such differences in rates are obviously not "based on a difference in the cost of service" and are in plain violation of law. Manifestly then, the rates charged the small consumer place upon him the burden of some of the expenses which should legally and equitably be borne by the wholesale customer, and it is a corollary that the small consumer is required to pay more than a fair price for his current. A difference of 1200 per cent between the wholesale and the retail charge for a public service commodity—when the difference in the cost of providing it cannot exceed 23 per cent clearly spells "unjust discrimination."

These public service companies then impose upon the customer rates based solely on the quantity consumed, notwithstanding the law made in Hayes vs. Pennsylvania R. R. Co.—12 Federal Reporter 309. "A discrimination in favor of parties furnishing the largest amount of freight and solely on that ground is a discrimination in favor of capital and is contrary to a sound public policy, violative of that equality of right guaranteed to every citizen and a wrong to the disfavored party."

"Discrimination is the arbitrary imposition of unequal tariffs for the same service."

These corporations charge and collect annually about $500,000,000 for the current which they sell in the United States; more than $350,000,000 of this amount is received every year from those whose "use value" is greatest, the householder and small store which can be compelled to "bear" the maximum charge. Of the $350,000,000 which is annually collected from the helpless customer, more than 40 per cent, or $140,000,000—unless the analysis of Mr. Jackson is defective—is exacted from the small consumer in excess of a reasonable profit.

The cost of service is by common law statute and judicial decision the primary principle upon which charges imposed by a public service company are authorized in every country where the English common law is the basis of jurisprudence.

Every customer who may require current during the peak period is properly chargeable with his pro-rata proportion not only of the entire cost of power house production, but of the repairs, depreciation and taxes also.

Any well balanced power plant which sells current to the public may employ its investment more continuously than a railroad, gas or water company. The cost of electricity sold by modern stations of 4000 or more kilowatt capacity rarely exceeds 4 cents per unit. "Public service companies may charge only a reasonable price." "All individuals," says the Court in McCall vs. Western Union, "have equal right both in charges and services," when they buy the product of a Public Service Corporation. If the consumer must pay 10 or 12 cents per kw.-hr., a profit of 250 or 300 per cent, it seems a demonstration that the charge is unreasonable.

The whole financial organization of these corporations is then predicated upon revenues which are derived from rates illegally imposed. While this wilful disregard of law may afford the promoter a profit, it might be prudent for the stockholder, who must ultimately pay the penalty, to understand the impending danger to his investment before the public service corporation is visited with such a retribution as has overtaken the St. Louis and San Francisco, Wabash, Pere Marquette and New Haven Railroads. For it has also been the policy of some public service companies which sell electric current to purchase competing plants and franchises at large prices on the theory that the public could be compelled to pay the interest on inflated capitalization.

THE SECOND INTERNATIONAL SAFETY EXPOSITION will be held in New York, Dec. 12 to 19, at Grand Central Palace, under the direction of the American Museum of Safety. The purpose is to show how the health and safety of the worker is being looked after in the various American industries, manufacturing, trades, railroading, building, business and engineering, as well as the methods which have been adopted for the welfare and education of employes. The scope of the Exposition will be limitless, embracing everything devoted to health, sanitation, safety, accident prevention, education, welfare, and the advancement of the science of industry. Each day of the "Safety Week" will be devoted to the exploitation of a special branch of safety work; there will be a manufacturer's day, a transportation day, a building trades day, a fire and explosive day and a greater New York day. Sunday, Dec. 13, will be known as worker's day, and the Exposition will be open then for all those whose work will make it impossible for them to attend during the week. Following the international practice, which was adopted at last year's Safety Exposition, there will be 5 grades of award for exhibitors in every branch of industry.

Introducing Jeremiah Judson, C. E.

CANTANKERATION EXPERT AND PROFESSOR OF MONKEYWRENCHOLOGY IN THE SCHOOL OF EXPERIENCE

SIX feet he stood, in his socks, slightly inclined to stoop, for which he was to be congratulated rather than blamed, as it told plainer than any written words that he had been through the mill and had come out with a fund of reminiscence that it falls to the lot of but few men to accumulate and possess.

He was inclined to silence rather than otherwise, and was at his best when there were few around him—a very few—men of his own heart, who were broad in their views and did not have to be told every detail in order to comprehend fully what he said.

If anyone had suddenly broached the impertinent question, "Say, Jerry, tell us a story. Tell us about some of your experiences as a trouble man and an engineer,"—if a query like this had been propounded, the chances are that he would have turned on his heel, lit a stogie and walked off in silence.

Like the real genius in any profession, he felt that what he did was something that anyone could do, irrespective of one's natural bent. When on the job, there was only one boss, and the only way to find out who it was, was to shirk, or do something radically different, that did not jibe with the scheme of the master mind.

Words were few at those times. Possibly for hours, after he had fathomed the depths of a man's characteristics, he would crowd the work by a word or a gesture. In this way, his gang soon became a silent gang when the men caught the spirit of the man in charge.

He knew when a man did a day's work and also, which is equally important, when he did not. He said that he could tell by the way a man handled a monkey wrench, or a hammer and chisel, how good a mechanic he was, or whether a mechanic at all. This was also the test of the wage supply. "Show that you can earn it and you get it," was a phrase he used to many a disgruntled boomer—a jack-of-all-trades.

If it was necessary to "call" a man, he waited until he had him out of hearing of others, and what he had to say was short and to the point and there was no mistaking the meaning. But while the language was as tempered steel, and the words cut, they did not leave a jagged wound, and the incident was forgotten at once. "You are not familiar with this work. Here is your money," was the usual expression and there was no appeal from the decision.

He was the soul of honesty and he expected everyone else to be the same. His tool chest was open on the job, and the help went to it for everything it contained that was needed; but he knew if so much as a center punch was misplaced. He trusted his men, and they soon knew it. They could not afford to pass up the good pay for the sake of his ill will and a tool they didn't want.

Such was Jeremiah Judson—Jerry Judson, the trouble man. As has been said, he was taciturn and it took several interesting experiences to awaken the reminiscent spirit in his veins, and "throw the belt on the tight pulley of his remembering machine," as one of the boys put it. But with several of the boys around him, at noon, in the shop—when he *was in*—or at the lodge meetings, which were held every other Saturday evening, a few little experiences warmed him up to his task, and when he started, it came from his tongue like oil flowing down a pane of glass.

"Well, sir, that reminds me of the time that——" was his opening phrase, always; it never changed. When those words came out in that soft, resonant voice, everyone else shut up like a clam. Well they knew that, so much as an inoportune gesture even, would throw his train of thought into the verbal ditch, and wreck the whole story.

So it gradually became a well learned lesson about the shop and lodge room. When the membership of the "story club" had swelled to not more than 8, it was tacitly understood that no more were to butt in. If they did—well, the story was not told, or if started, was run in on the first siding with the plea that he "would stroll around a little."

Jerry was a real mechanic, one of the natural kind who can do things without tools, for he was of the opinion that anyone could do a job if he had all kinds of tools at hand. What did he do? Well, after a man has been "on the road" for a number of years with an equal number of years at all tricks of the trade, from a No. 5 scoop, on up the line, you have his history. There were few things in and about a power plant or in connection with transmission of power, especially if steam was the motive power, but what he had been obliged to do at some time in his career.

On many of the occasions when out on a job, little things came up that had to be settled without friction, if possible, between the several machine contractors on the job. Thus did he learn the fine art of diplomacy in the school of experience. And if he thought that his firm was at fault, he was just as ready to say so as he was to place the blame on somebody else if he was convinced that it belonged there.

As a sample of his skill as a diplomat, the following may serve. While in a distant state, where the facilities were not at all good for getting in touch with the house, one of those little slips in contracts came up for settlement.

The engine was a direct-connected Corliss, with a revolving field generator on the shaft. As the electrical contract also included the erection of a switchboard of considerable proportions, a representative of the generator firm was on the ground; his name, we will say, McCanny.

There was a clause in the contract with the engine builders for whom Jerry worked at the time, "that the engine shaft with generator, was to be installed by the representative of the generator manufacturer under the supervision of the erecting engineer representing the engine builder."

When it came time to install the shaft, Jerry approached McCanny and said he was ready for McCanny

to proceed with the shaft. This was news to McCanny, and a comparison of the 2 contracts showed that while the engine contract called for the installation of the shaft as stated above, the contract between the purchaser and the electrical concern made no mention of it. So McCanny took the stand, and justly so, from his contract, that he had no hand in the matter.

From the location, it would take several days to get in touch with the 2 concerns and the delay would amount to something financially. So, after discussing it at length, Jerry set forth the fact that there at least must have been some understanding between the engine and the generator builders in regard to the matter, but that the latter must have omitted it in the contract with the purchaser. This looked reasonable.

"I'll tell you what we will do, McCanny," said Jerry. "If you are agreeable to the proposition, let us consolidate the gangs, yours and mine, and work in unison on the matter and get it out of the way as soon as possible. I will take charge of the work as far as putting in the shaft is concerned, and you of the setting of the field ring. I will do all of the grouting if you set the falsework around the bases to retain the cement.

"We will keep track of all time, make out 4 copies, keep one each, and send one each to your firm and mine, and let them settle it themselves. How does that strike you, McCanny?"

So they carried out the project without a hitch and sent in the reports. Before the job was completed, both received word from their respective firms complimenting all concerned on the fair method of settling a little matter that had been overlooked in copying the contract.

This shows briefly how resourceful Jerry was and how prone he was to be fair to all concerned.

While Jerry was a road man in every sense of the term, he was so favored that between jobs he was in the shop for a few days. Thus it was that frequently, if conditions were right, he was permitted to attend the meeting of the engineers, or to while away the remainder of a noon hour with a short story, provided that someone else told one that "threw the belt on the tight pulley of his remembering machine."

And it so happened that one noon they were all grouped about a large rope wheel that was part of a rolling mill equipment, commenting pro and con on the rope drive problem.

"I wonder if those ropes don't get tangled up sometimes," said Cadwell. "Seems to me that if they ever got started they would pull down the whole outfit of shafting and pulleys."

"Well, sir, that reminds me of the time——" began Jerry; but it was postponed till the next day, as the big whistle boomed out the hour of 1 o'clock, and Jerry went over to lay out the valves on a blowing engine cylinder.

(To be continued.)

Ice Making Plant

GAY & ORR COAL AND ICE CO., OSCEOLA, ARK., DRIVEN BY OIL ENGINE AND USING RAW WATER ENTIRELY

WHILE we do not usually associate the idea of progress in commercial and technical activities with the small town, nevertheless in the little town of Osceola, Ark., is located one of the most up-to-date ice factories in existence today. Osceola is a town of some 2000 inhabitants, situated on the western bank of the Mississippi River, and is favored with exceptionally good railroad facilities.

Scarcity of ice in Osceola caused Messrs. B. F. Gay & W. P. Orr to take over the plant of A. Driver, with a view to enlarging and improving it. At the time of acquiring the business, the ammonia compressors in use were 3 Remington machines, of 2, 3 and 4-ton ice making capacity respectively. It was decided to displace the 2 smaller units, and Messrs. Gay & Orr made a rather extensive trip throughout the country, inspecting ice making plants of practically every make. After this trip, these gentlemen placed their order for the 14-ton Arctic-Pownall raw water ice plant herein described.

AMMONIA COMPRESSOR

THE BUILDING in which the plant is housed is a one-story structure, about 72 ft. 6 in. deep by 56 ft. 3 in. wide, with concrete foundations and substantially constructed throughout. Figure 1, showing zinc etching of the floor plan, will give a good idea of the plant as a whole. At the south-east corner of the building is the office, next to which is the engine room, which is about 44 ft. by 23 ft. 8 in.

Along the south side of the room is the horizontal Arctic double single-acting ammonia compressor, as shown in Fig. 2. This machine has a 9-in. bore, 13½-in. stroke, the construction being illustrated in Fig. 3. Suction gas enters the compressor through the grated ports in the center of the cylinder. The 2 piston heads are really combined pistons and suction valves, the valves being without springs or bolts, endless forgings of heat and oil treated Chrome Vanadium steel. Discharge valves are made of high carbon steel, with a large bearing, and so located as to ensure perfect drainage and freedom from shock or strain when pumping wet gas. The compressor has the water jacket cast in one piece with the cylinder and heads completely water jacketed, this being one of the unusual features of this compressor, also a portion of the stuffing box is water jacketed. It will be noted that both the piston heads and cylinder heads are flat, thereby eliminating excessive clearance.

Should any occasion arise for an examination of the interior of compressor, it is unnecessary to break pipe connections on the heads in order to remove the piston; in fact, the piston on a 40-ton compressor may be removed in less than 5 min. after the ammonia has been removed from the cylinder, which gives some idea of the simplicity and accessibility of this construction. This compressor is so built that the suction gas enters the compression chamber without appreciable decrease from the pressure existing in the suction line, due largely to the valve design.

Belted to the ammonia compressor is an oil engine, which also operates the other ice machine, and furnishes all power required about the plant. In one corner of the engine room is the pump for supplying the water to ice cans, the source of supply being deep wells, which furnish water pure and wholesome, although turbid, holding a deposit of silica, clay and iron; but the ice is perfectly clear and pure.

Plant Arrangement

It will be noted that a portion of the north side of engine room is not walled in but leads directly to the ice tanks, as shown in Fig. 1, in which the ice chute is seen. has at one end a steel precipitating tank, into which all impurities are drawn from the water during the freezing process. Running lengthwise of the ice tank room, is the brine tank, in which is immersed an Arctic-Pownall shell brine cooler, in which the brine is cooled 3/8 of one degree F. in each passage through the cooler. The slight difference in the brine temperature at the inlet and outlet connections of the cooler causes a very even rate of freezing to occur in every part of the freezing tanks. Located at one end of the shell cooler is the ammonia purifier by means of which the charge of ammonia is kept in a pure condition, thereby retaining its original efficiency.

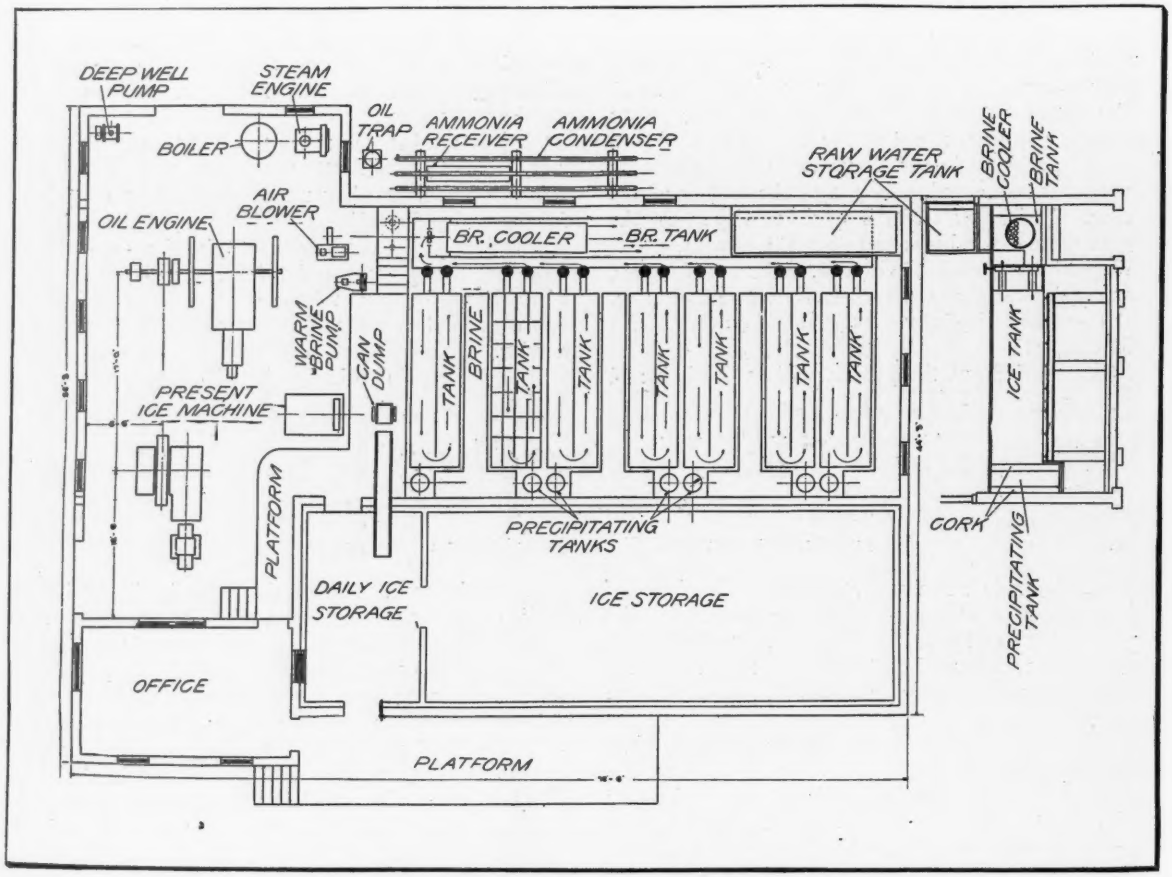


FIG. 1. FLOOR PLAN OF OSCEOLA ICE PLANT

In the engine room and near the ice tank is the noiseless, rotary air blower, belted to shafting, operated by the oil engine, and furnishing the air for agitating the water in the ice cans, this air being utilized without treatment of any sort. The pump for interchanging the brine between the ice tanks and the storage tanks, in process of thawing the ice from the cans is located next to the air blower.

The ice tank room is 48 ft. long by 25 ft. 2 in. wide; by referring to the zinc etching of the plant layout, it will be noted that there are 7 ice making tanks, 6 of which are arranged in batteries of 2 each, the remaining tank, at the south end of the room being operated separately. Each of the 7 ice making units contains 28 300-lb. Arctic-Pownall raw water ice making cans, and

Of this Arctic-Pownall raw water system, the principle of ice making may most readily be explained by reference to Fig. 4, which gives a standard layout, differing from the Osceola installation only in that there are 8 ice making units instead of 7.

Method of Freezing

Assuming tank No. 1, holding 28 cans, to be frozen and ready to harvest, the inlet and outlet valves controlling the flow of cold brine from the shell type brine cooler are closed off. The tank is allowed to stand for about an hour to temper the ice, and the brine in this compartment rises in temperature, as the ice tempers. At the end of an hour or more, a 2½-in. centrifugal pump, which has mains leading to all of the ice making

tanks, is started and the inlet and outlet valves of this frozen compartment are operated. The brine pump takes the cold brine out of this tank and circulates it through a coil in the water storage tank. This transfers the cold in the brine of this one ice making compartment to the water in the storage tank, which holds just enough water to fill all of the cans in one compartment, consequently the temperature of the water in the storage tank is reduced and the temperature of brine in the one tank to be harvested is raised. The pump is allowed to circulate this brine until the brine reaches a temperature high enough to thaw the ice loose from the cans, which are stationary in the tank.

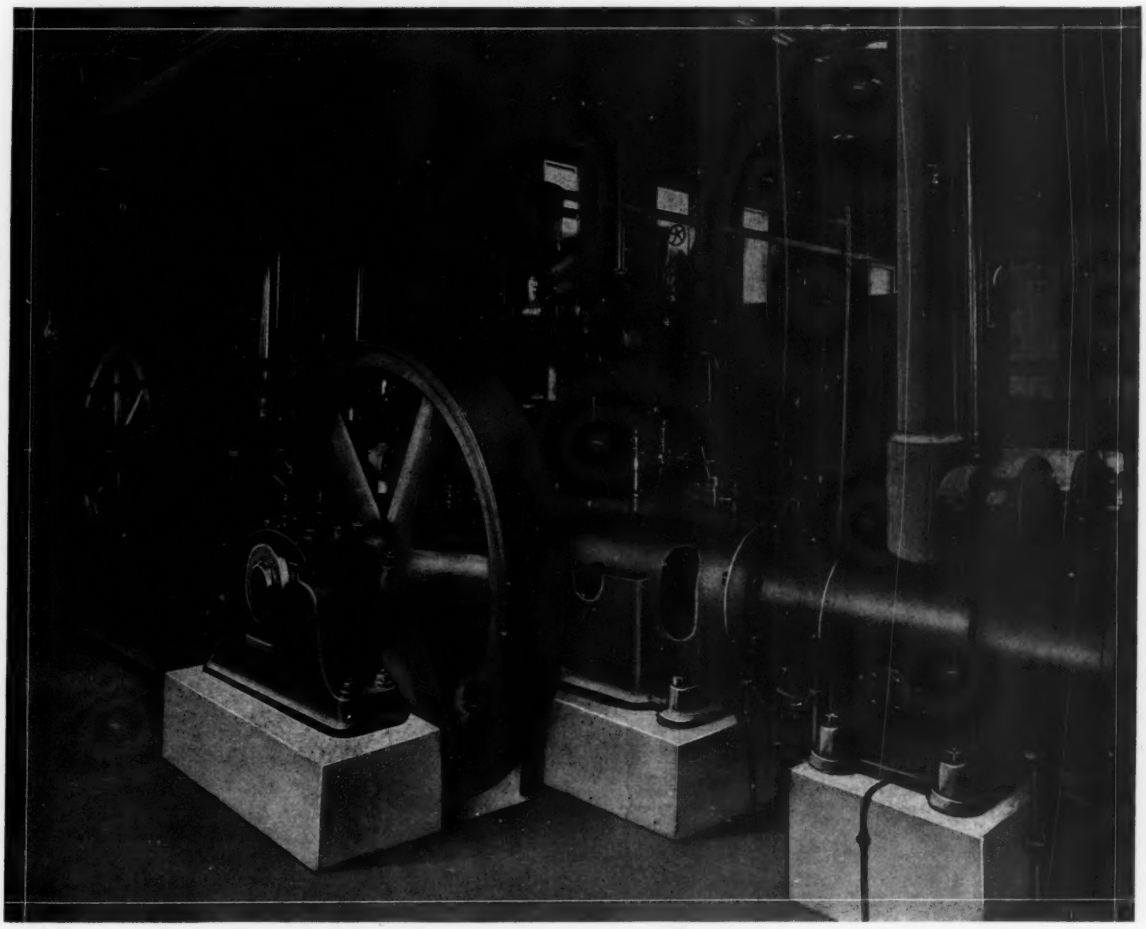


FIG. 2. COMPRESSOR ROOM OF GAY & ORR PLANT, HORIZONTAL ARCTIC COMPRESSOR IN FRONT

At this point, the brine pump is stopped, the inlet and outlet valves above mentioned, connecting the brine pump to the coil in storage tank, are then closed, the ice is harvested in this tank and then by opening the one valve, the cool water in the storage tank is caused to flow into the cans in this one compartment, filling them to a predetermined level. The ice is lifted out of the cans by means of small hooks which are frozen into the side of the block; when the ice is set in the dump, these hooks readily drop out of the block.

After the ice is all removed from one tank, the cans are refilled with raw water as above stated, by merely opening one valve, the water entering through connections on the bottom of the tank. Every can is filled to exactly the same height, which is controlled by an overflow located in the precipitating tanks shown at the end of the ice making tank.

Air Agitation

Air connections for circulating air, to agitate the water during the process of freezing, are also all connected to the bottoms of the cans and so arranged that by opening one valve the air is automatically turned on to all of the cans, the same quantity of air being furnished each individual can. After opening the air valve, the warm brine valves are shut off, then the cold brine valve is opened, which permits the cold brine again to circulate around the ice cans. The air is admitted to the can through a syphon connection located in the flange on the bottom of the can. The air in entering the nipple creates a syphonic or ejector action which causes the water to flow in through the can through the inlet water header, thus increasing the height of water in the can to slightly above that of the water in the precipitating tanks. This syphon is so proportioned that it draws

about a gallon of water per minute into each can from the precipitating tanks, while the same amount of water flows out of the can into the precipitating tanks, thus carrying away all foreign matter as fast as thrown out and depositing it in the precipitating tanks.

Originally, it was intended to use a small quantity of distilled water for filling the cores of the blocks; but the quality of ice made, when simply drawing off all core water by the manipulation of one valve, then introducing fresh water by means of a single controlling valve, has proven so entirely satisfactory, that this method of completing the freeze has been adopted.

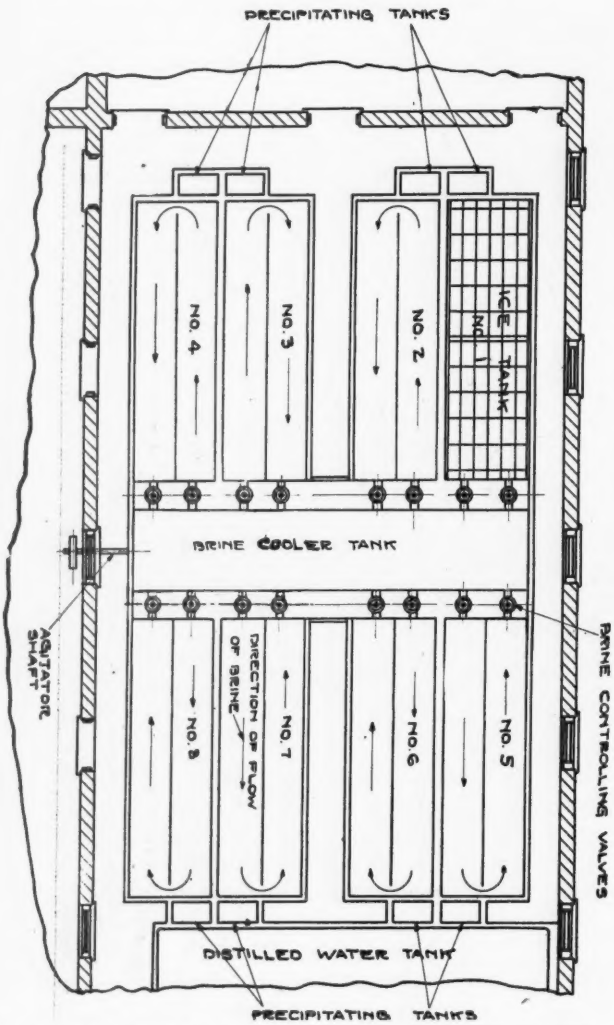


FIG. 4. SCHEME OF ARRANGEMENT OF ICE MAKING UNITS

In the air line between the blower and air headers is placed a reducing valve for the purpose of maintaining an absolutely uniform pressure, while a small bypass valve is placed on the compressor to govern the amount of air.

Figure 5 shows the sectional elevation, and the method of supporting the ice making tanks, which are carried on concrete piers on top of which are placed small I beams and on top of these a tee bar between each row of cans. The bottom of the tank is about 5 ft. 6 in. above the floor, making it easily accessible for inspection. Ice manufactured is equal in quality to plate ice, but the plant occupies less than half the space of a plate plant and insures blocks of uniform size, with less than half the labor for harvesting required in the ordinary can plant. The blocks are without white top, and free from taste and odor; further, there is no danger of flooding the cans and weakening the brine solution, owing to the fact that the height of the water is automatically controlled by means of the overflow in precipitating tanks.

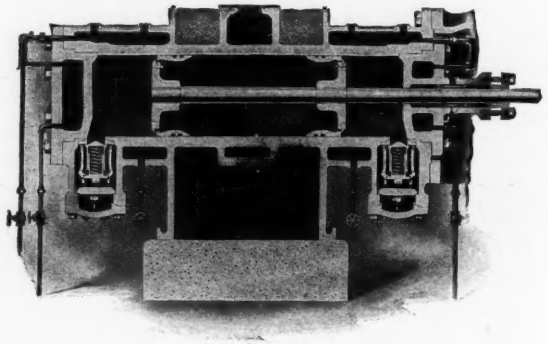


FIG. 3. SECTION OF ARCTIC HORIZONTAL COMPRESSOR CYLINDER

Figure 6 is a view of the ice tank room, showing the 7 ice tanks, the brine tank located to the left of the picture and the water storage tank in the left corner at the end of room. Brine inlet valves are those whose stems only project above the tank, while the outlet valves have both the stem and bonnet in view. The small valves just showing above the tank top are the warm brine or thawing off valves to and from the storage tank. It will be noticed that a block of ice is shown suspended on top of the tank, held by the small lifting hooks which are hung over the top of each can, and which freeze into the sides of the ice, but are removed without difficulty, when the block is placed in the ice dump.

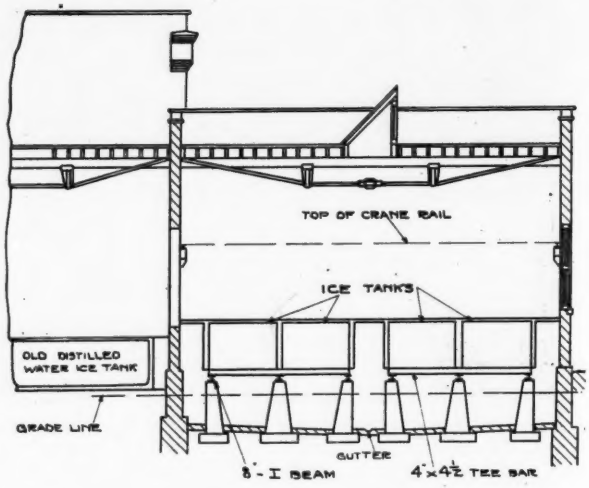


FIG. 5. SECTIONAL ELEVATION OF FREEZING ROOM

These ice making tanks are insulated on the sides and at one end with 4 in. of cork board, while between the 2 tanks arranged as a battery, is 6 in. of granulated cork, which is also used to insulate the precipitating tank on all sides, 25½ in. of granulated cork being used between the ice tank and brine cooler tank.

Storage and Delivery

Next to the ice tank room, is the ice storage, which is 40 ft. 5½ in. long by 17 ft. 4 in. wide, and is insulated with corkboard on all walls, floor and ceiling, being piped throughout with direct expansion coils. The daily ice storage room is located next to this apartment, and as will be noted from Fig. 1, the blocks may be slid down the chute directly from the dumping platform at the side of the ice tank, into the daily ice storage room, at the opposite end of which is a door leading to the loading platform. The entire arrangement is such as to diminish handling the ice. The office is located in such a manner as to command a view of the entire plant, including the engine room, ante-room, loading platform, etc.

Outside of the building, on the side opposite the loading platform, is the oil trap, ammonia receiver and ammonia condenser, the latter being made up in 3 sections of the double-pipe type, each section 10 pipes high and 20 ft. in length. All fittings used on the ammonia lines are of the newest Arctic design and where flanges are required, these are of drop forgings and arranged for 4 bolts or more.

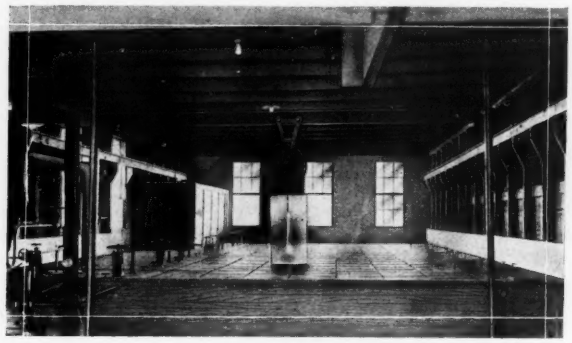


FIG. 6. VIEW IN THE ICE TANK ROOM

The plant has now been in successful operation for some little time, although its completion was hampered somewhat by the effects of the disastrous floods along the Mississippi River, experienced in the early spring of last year. During the erection, all men were obliged to leave work for a time, being pressed into government service to aid in strengthening the levee banks along the river. Pay for such labor was granted only to the negro workers, as it was assumed that the white men were in a large measure protecting their own property. In any event, results were such that no great loss resulted to the Gay & Orr plant from the flood conditions, and its present operation is showing gratifying results in the use of the system described.

To clean dried paint from brushes or vessels, use amyl acetate. Soak until the paint is softened and it can readily be removed. The final cleaning should be with oil of turpentine.

Peat Fuel Briquets*

As Made by the Herbein Process with Crude Oil Binder. By Robert Blei

Because of the advancing price of all fuel commodities, economic scientists and others are seeking new sources of fuel supply, and contriving means of conserving and more perfectly utilizing the present supplies. The tendency toward more efficient utilization is shown in the development of interest in saving fuel wastes, peat and combustible material by briqueting.

Briqueted fuel calls for such requirements as heat production for density in shipments equal to coal. Briquets must be hard, durable, allowing little or no breakage in transportation, containing no sulphur, must not disintegrate in burning in stoves or under boilers, produce no soot, no odor, no clinker and contain not over 6 to 10 per cent of ash.

All nations have long sought the concentration of high heat value, at a minimum cost, with no perceptible ash increase, but Dr. Geo. W. Herbein has so combined high-heat-value crude petroleum with low-heat-value peat, the binding material amounting to only a few pennies and the increase in added ash to only 1/1000 per cent.

Crude petroleum, residuum oils from petroleum refineries, heavy baume oils or waste oils are all that are necessary for the production of "Herbein Koal." Such oils are cheap and often a drug on the market, heavy asphaltic base oils in California, Oklahoma, Texas, Cuba, Mexico, Russia, varying in price from 65c to $1.20 or $1.44 a barrel, f.o.b. Pacific Coast, Atlantic Coast and Middle States in order of their notation.

Dextrine, a product of corn, commonly used for the manufacture of cheap mucilage, in paper making, printing of cloths, coating paper envelopes and stamps for adhesive purposes, a product of yearly growth, costs $3.40 a hundred pounds.

Lime, ordinary slacked lime, produced by burning limestone, according to locality, ranges from $8 to $14 a ton.

Primarily it is and was the object of the inventor to find a cheap and non-ash-producing binder, and his ash as added, only amounts to 1/1000 per centum to the ton, while his entire binder costs less than 8c to each ton, yet giving a hard form for market, which burns freely under easy regulation in stoves without breaking up and disintegrating in the fire box.

In Herbein briquets of peat, to a ton of raw material is added a half barrel of crude oil and 2 lb. each of dextrine and lime, all which is then compressed into briquets, forming a hard, dense, black lump, unbreakable in transportation, burning freely with a long, clear flame, which, indeed, passes completely around the oven in cook stoves and ranges. These briquets ignite readily, burn slowly and evenly when the drafts are properly arranged, and produces no soot. The ashes amount to from 6 to 8 per cent, and are fine like wood ashes.

The heat value is 10,000 to 11,500 B.t.u., according to the amount of crude oil added, at a cost of about $1.15 to $2.15 per finished ton.

*From a paper before the American Peat Society.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Boiler Setting Used When Burning Sawdust and Coal

NOTING A recent question about a boiler setting to burn sawdust and coal, I present herewith drawings showing what my boiler setting was, and how I changed it to good advantage in fuel economy. When I took charge of the plant, the boiler was set as in Fig. 1, with an arch over the bridge wall consisting of 2 courses of fire brick and extending 4 ft. to the rear of the boiler. These arches lasted from 3 to 6 months, were a constant nuisance to repair, and after they were down it would take a mason 2 days to put them up again. The smoke ordinance in this city is pretty strict, and to prevent smoke they were all right, although expensive.

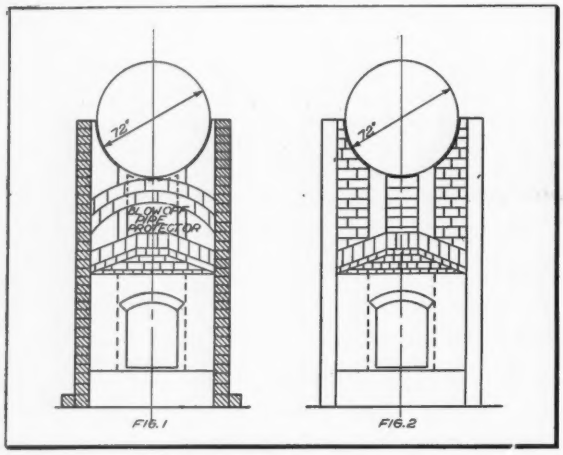


FIG. 1. ORIGINAL BOILER SETTING WHICH GAVE TROUBLE
FIG. 2. REVISED SETTING FOR COAL AND WOOD

One day, one arch in boiler No. 2 came down again and I hit upon the plan as in Fig. 2. The deflecting piers are the same as in Fig. 1, but instead of the arch, we put a pier on top of the bridge wall, which is 24 in. square and 23 in. high. The boiler is 44 in. from the grate and the bridge wall is 20 in. high, having 1 in. for expansion between boiler and pier on bridge wall. The deflecting piers in the rear of the setting are 4 ft. from the rear of the bridge wall and are 18 in. wide. I put this under the boilers, and with the same kw.-hr. output as in 1912 and the same amount of lumber cut, of which 30 per cent is charged as fuel for the boiler room, the saving in coal amounted to $450.70. I think this is due to removing the arches, which covered 24 sq. ft. of heating surface, with 2 courses of fire brick. We burn shavings and coal and are not troubled with smoke, which I think is due to the breaking up of the gases by traveling around the piers. JAS. BROWER.

Babbiting a Crosshead Shoe

I READ with much interest the article, "Babbiting Crosshead Shoes," by Tom Jones, in the July 1 issue, and it brings to mind a similar job I had some 2 yr. ago. It happened that one of our dynamo engines broke the babbit on the lower shoe, and as neither of the engines could be depended upon to run any great length of time without a breakdown, it meant to repair the shoe as soon as possible.

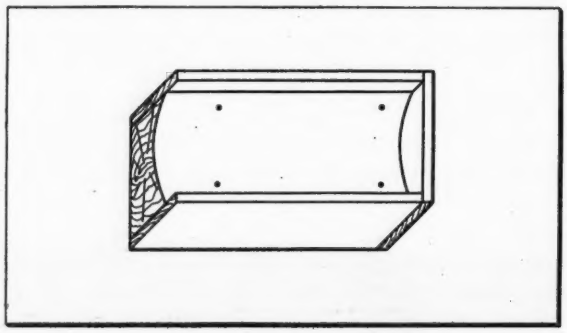


FIG. 1. SHAPE OF BABBIT MOLD

The engines were both 430 hp., direct-connected, 200 r.p.m. The first thing I did was to get the diameter of the bore of the guides, then I went to the carpenter shop and ordered a hardwood block some 3 in. longer and 1 in. wider than the crosshead shoe, and 4 in. thick with one end squared; this we put in the 32-in. lathe and bored to the same diameter as the guides.

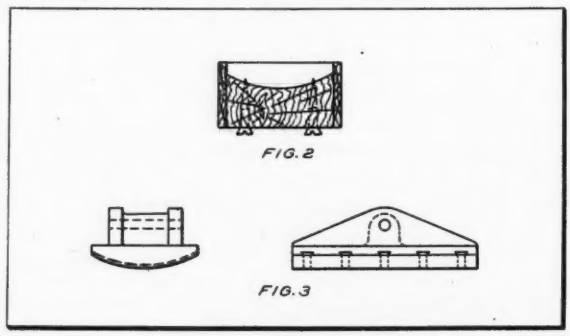


FIG. 2. END VIEW OF MOLD
FIG. 3. CROSSHEAD SHOE

In the meantime, we had taken the shoe out and cut away the old babbit on each corner to leave the iron exposed; when the boring was finished on the wood block, I sent it to the carpenter shop and had the sides trimmed down to the exact width of the shoe, then drilled a small

hole in each corner for wood screws, we then placed the shoe in this form and set up on the screws to just touch the iron where we had cut away the babbit, which gave the exact thickness for the babbit, then we nailed to each side and one end strips of board high enough to prevent the metal running out, the other end was left open for pouring.

Next, we removed the shoe and cut out all the old babbit, gave the inside of the form a good coat of laundry soap, returned the shoe to its original position in the form, and after clamping securely in place we poured the metal, waited sufficient time for it to cool, and then removed the wood form.

Result—a nice clean casting without sand, clay or blow holes, after rounding off the corners with a file and cutting the oil ways it was ready for business, and when placed in the guides it was almost a perfect fit and the wedge bolt came to its original position when tightened. I do not think the job could have been done as quick by turning off in the lathe, as it would necessitate removing the crosshead and making a mandrel. The whole job required about 8 hr. from the time of stopping to starting the engine. "A. RUFNEC."

Minnesota Examinations

HAVING READ considerable in Practical Engineer relative to Massachusetts examinations, I thought the readers would perhaps be interested in what other states were doing along this line and therefore give a list of questions asked me when I applied for my first-class license. It is now some years since I took my examination and, as a consequence, I can remember but a few of the most important ones.

Before asking any of the questions it was, of course, necessary for me to fill out an application blank wherein I was asked my name, age, residence, nationality and was required to swear that I had had at least 1 year's power plant experience.

Among the most important asked were:

1. With what kind of boiler have you had experience?
2. How are fusible plugs made?
3. What are they used for?
4. Where are they located in a return tubular boiler?
5. In a fire box boiler?
6. In a B. & W. Boiler?
7. What care do fusible plugs require?
8. How would you proceed to clean a large return tubular boiler?
9. Is a return tubular boiler set level?
10. Which end should be the higher?
11. Why?
12. How do you protect the blowoff pipe in the combustion chamber from burning out?
13. How would you determine the amount of water above the upper row of tubes if it was just within sight in the gage glass?
14. What is meant by dead water?
15. If, when your engine is heavily loaded, the water in the boiler should suddenly rise to the top of the gage glass, what would you say was the cause?
16. How would you remedy the trouble?
17. What does the steam gage show?
18. Which is the safer, a light or a heavy steam gage; that is, one registering too low or one registering too high?
19. If you were called upon to order a smokestack for a boiler, how would you determine the required diameter?
20. In setting a return tubular boiler, how much space would you allow between the top of the bridge wall and shell of the boiler?
21. How would you determine the size of safety valve required on a boiler?
22. What would be your first duty upon entering a boiler room in the morning before starting the fires?
23. What would you first do upon assuming a position as engineer?
24. Explain fully how to set valves on a double-acting pump.
25. Is there any limit to the height a pump can lift water?
26. If so, what is it?
27. How and where would you connect a feed line to a boiler?
28. What benefit is a feed water heater and how are they constructed?
29. Explain the operation of an injector.
30. What is a steam engine?
31. Name the principal parts and tell their functions.
32. How can you determine the direction of rotation of an engine before turning on the steam?
33. What is meant by running over? Running under?
34. How would you proceed to set a slide valve?
35. How would you proceed to change the direction of rotation of an engine?
36. How is the speed of an engine regulated?
37. Explain how a throttling governor regulates.
38. Have you ever had any experience with shaft governors? If so, explain.
39. What is a horsepower?
40. Give a formula or rule to calculate the horsepower of an engine.
41. What does r.p.m. mean?
42. What does m.e.p. mean.
43. Can the point of cutoff on a slide-valve engine be changed?
44. When applied to an engine, what do you understand by the word "automatic"?
45. Is the Corliss an automatic engine?
46. What is meant by clearance in an engine?
47. Why would you give an engine lead in setting valves?
48. How would you proceed to line up an engine?
49. If in lining up an engine you found the head end of the cylinder low, how would you remedy it?
50. What is a lubricator? Explain how they work.

At the conclusion of these 50 questions, which I had answered to the best of my ability, the examiner, instead of informing me as to whether or not I had passed a satisfactory examination, started talking on current

events, which he continued to do for at least a half hour. After I had almost fully made up my mind that he had forgotten my examination and especially the result in which I was interested, he told me that of all of the applicants who had ever come to him my answers were the best ever given. He concluded by saying that if the law allowed him to do so and if such a thing were possible, he would gladly give me more than a first-class license; but as it was, I received the best to be had.

Anyone having had at least 1 year's experience as a fireman or oiler, who can answer the foregoing questions correctly, will be granted a first-class license in the state of Minnesota. F. M. J.

Goodman's Averager

FOR THE young engineer that does not possess a planimeter, the averager here described will prove instructive and, by careful manipulation and a little practice, accuracy can be obtained. The instrument should be carefully set to the total length of the diagram to be measured. The hatchet end should travel on a good surface, such as drawing paper, and, finally, the diagram should always be reversed so that the (mean) travel of the instrument may be read off. With these precautions, it will be found valuable in quickly determining the average pressures. It is not liable to damage by rough usage and can be made by any engineer.

The tracing point, T, Fig. 1, may be made of steel wire with the point slightly rounded, and is fixed to the horizontal bar. The other leg of the instrument is carefully ground to a knife edge. The distance between the knife edge and the tracing point is adjustable by sliding the former along the horizontal bar, by means of which the instrument is set to the exact length of the diagram to be measured. There is a small weight, W, used to prevent the knife edge from slipping. Suppose the diagram, Fig. 2, is to be measured. Choose a point, A, somewhere about the center of the figure, and draw

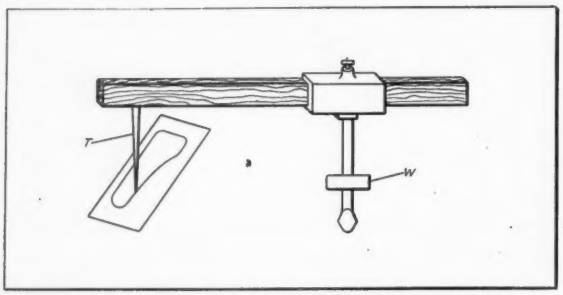


FIG. 1. AVERAGING DEVICE

any line, AB, to meet the boundary. The tracing point, T, is placed upon A, and the hatchet end or knife edge is placed so that the mean position of the instrument is roughly square with AB, as shown at X. The position of X is marked by pressing the knife edge upon the paper. Now take the tracing point lightly in the fingers, so that the movement of the knife edge end is not controlled by the pressure of the hand. Travel from A to B, then follow the direction of the arrows round the boundary of the figure, say in a clockwise direction, returning to the point B, thence back to A. The knife edge will then occupy a new position at Y, which is marked as before. The indicator diagram should now be turned about the point A through 180 deg. The figure is again traced by the point T, but this time in a contra-clockwise direction, following the dotted outline, Fig. 2. When the point again returns to A the knife-edge will have traveled back towards X, say to X_1. The mean side movement of the knife-edge gives

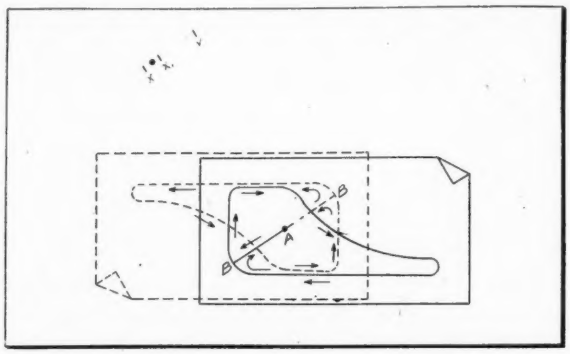


FIG. 2. DIRECTIONS FOR TRACING INDICATOR CARD

at once the average height of the diagram. Thus, suppose the distance from Y to the dot between X and X_1 is measured off at 0.50 in.; then this is the average height of the diagram, and multiplying 0.50 by the scale of pressure gives the mean pressure upon the piston. The area of the figure traversed by the boundary is equal to the side travel of the hatchet multiplied by the length of the diagram. W. H. PEARSON.

Ammonia Rod Packing Trouble

I HAVE lately read some articles on knocks and other trouble which has been finally traced to the rod stuffing box of the ice machine compressor.

A similar case came to my notice a few years ago, but was discovered by an indicator diagram instead of any outward sign or noise.

While taking cards from a number of double-acting horizontal ammonia compressors, one of the cards showed an excessive clearance at the frame end. First, the discharge valve was taken out and examined and then the suction valve, but both were found O. K. Then we decided to take the piston out and see how that looked. We began pulling the rod packing out and all the rings outside of the oil lantern were so good that we saved them to put back. We then screwed 2 long eyebolts into the lantern to pull it out, but it refused to come. One man worked at that lantern for over an hour and only succeeded in breaking the eyebolts.

We then unscrewed the rod out of the crosshead and pulled the piston out. A man crawled into the cylinder with a bar to knock the stuck lantern loose. He went in and out again in about half a minute and told me to take a look. I crawled in and found the lantern tightly stuck in its proper place, but not so much as a string of packing was between the lantern and cylinder.

We got the lantern out and found it full of chewed-up packing in the space meant for oil. On trying the

lantern for fit on the rod, it was found to have over 1/16 in. clearance, so it was rebabbited and bored out to a sliding fit. The oil pipes were all disconnected and packing was found plugged in all valves and in places in the pipe. We got them all cleaned out, put the piston back, packed the rod and were soon started again. Then, on using the indicator, the cards were found to be as good as expected or looked for on a compressor of that style.

This rod had showed no signs of heating or given any trouble whatever and it might have been running in the aforesaid condition for a day or more. This compressor had been indicated a week before and it was then all right.

On compressing, the space where the packing should have been was filled with gas at a high pressure. In this case we were carrying 230 lb. and were thankful it was not higher. On the return stroke, this compressed gas expanded back into the cylinder and held the suction valve closed till the piston had traveled some distance.

Things like this can happen and reduce the capacity of the compressor considerably before being located. Use the indicator once a week on ammonia compressors, if possible, and whenever a small leak appears you will find it. A. G. SOLOMON.

Blowing Down Boilers

I THANK Fred Eckley and Frank C. B. Speace for their comments on my letter of May 15 on blowing down boilers, as by making comments on another's ideas we bring out new ideas.

I do not think Mr. Eckley read my article right or he did not understand it; perhaps I did not make it plain. I am in charge of a water pumping station which has a capacity of 6,000,000 gal. per 24 hr., running nearly all the time. If I were shut down every night, as some engineers are, no doubt I should blow my boiler down every day just before starting the fire so as to remove what sediment I could. It has been my experience when a boiler is in continuous action that mud is circulated throughout the water, and it is impossible to blow much mud out. I have found my boilers in better condition when I do not blow off. I am not running my boilers at the full rated capacity and would not at any cost.

Mr. Eckley said he did not think many would try my plan; perhaps not, but he did not give good reasons why he would not try it, other than getting rid of the mud. Muddy water is not half so bad as scale and blowing away the compound.

Speaking of foaming, when certain impurities, such as alkali or soda in excess, grease, soap, some kinds of animal and vegetable oils, are present in the water, the boiler will foam. Mud or solids do not cause the boiler to foam. Foaming is suds or, otherwise, soap. Priming may be caused by insufficient steam space, due either to the design of the boiler, or to the water being carried too high by a sudden release of the pressure, or by blowing off the safety valve, poor circulation of the water, starting the engine too quick, or too large a steam pipe from boiler to engine.

Now, if Mr. Eckley will just read my article over carefully and make note of the analysis, he will find that he has overestimated the amount of scale I have; I fail to see where he finds it. Here is the per cent of solids shown in the last analysis:

1. Hardness—moderately hard.
2. Magnesia in excess. (This is the worst and most troublesome thing I have to contend with.)
3. Alumina clay, trace only.

I use only 311 cu. ft. of water in each boiler in 24 hr., and the amount of scale found was 52 lb. in one month. FRANK W. BOHE.

Experiences with Rope Drives

A ROPE transmission usually behaves in a satisfactory manner, but it has its little peculiarities that must be taken into consideration if you would keep out of trouble with it. One is that sudden changes in speed or load are apt to start the ropes to swinging and before you realize it, a rope has jumped out of its groove and, especially if it is a continuous system, you have a wreck and are lucky if you do not tear your lineshafting down. As regards this last, we have been lucky in 2 small wrecks we have had lately.

We use a well-known belt dressing on our ropes and apply it by pouring it in a groove of the sheave with the rope traveling slowly, regulating the speed with a clutch. I sent 2 men to oil the ropes and through absent-mindedness or a desire to do it differently, they started up the engine, which is of the internal combustion type, and instead of regulating the rope speed with the clutch, they threw the clutch in and slowed the engine down all they could with the governor. Probably the engine did not fire regularly or the governor control the speed closely, for the ropes on 2 drives jumped off, wound around the clutch jaws, breaking the rope in two and left one tension carriage hanging down between the track rails.

The second wreck was caused by starting the engine up with the main clutch locked in. We always, except in this instance, start the engine and bring it up to speed, then throw the clutch in slowly; but this time the clutch was not unlocked and a wreck resulted that took us all day to straighten out. It is just as well to look out with this kind of a drive for sudden fluctuations in load or speed. We would probably not have had either of these accidents with a steam engine, but a gas engine is quite likely to be a bit jerky at times.

Much of the dressing used or recommended for ropes is of no benefit whatever; a dressing, to be of any value, must not only keep the outside of rope soft and pliable, but it must have the power to penetrate the rope and keep it in that condition all the way through. In some cases, the right kind of dressing or the lack of it means the success or the failure of a rope transmission, especially so as in our case, where the ropes run in a hot, dry atmosphere; in such conditions as these, the fibers get dry and hard and break. You can easily tell whether you need to use a dressing, as it will take a week to pick the stickers out of your hands after making a splice on one of these dry ropes.

J. O. BENEFIEL.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Marine Engines and Boilers

WHAT IS the modern way of placing liners in marine engine cylinders? What are they made of?

2. What are the constituents of salt-water scale?

3. In ocean-going steamers, how much salt is allowed in the water before changing?

4. Of what are retarders, such as used with forced draft, made?

5. Kindly tell me of some book containing the latest patents on marine machines. Where could I obtain further information on this subject? W. G.

A. The liner used in the cylinders of marine engines is made of hard cast iron or Whitworth steel accurately bored inside and turned to a neat fit in the cylinder. The bottom of the liner is bolted to the lower cylinder head either with a ground joint or with a thin asbestos gasket to prevent the steam leaking into the cylinder from the jacket. The top of the liner is secured to the cylinder but not rigid, as provisions must be made for vertical expansion of the liner, and at the same time prevent leakage at this point. The section of the cylinder and liner illustrated, shows how this is done. In one form of joint, a copper ring is bolted to both the cylinder and the liner. This ring is pliable, and allows the liner to expand independently of the cylinder. Another type, shown in Fig. 3, uses packing in the recess which is held in place by a steel ring bolted to the liner only. The bottom cylinder head is usually cast solid with the cylinder, while the top head is held in place in the usual manner. The steam space between the cylinder and liner in the body of the cylinder is about 1 in. wide.

2. The elements found in the scale of marine boilers using some sea water will vary to some extent, but consist chiefly of chloride of sodium (common salt), sulphate of lime (plaster of Paris), carbonate of lime (limestone), chloride of magnesium and traces of various other substances. One analysis of scale from sea water gives the following: carbonate of lime 1.0; sulphate of lime 85.5; magnesium hydrate 4.4; salt 4.8; oxides of iron and alumina 0.3; sand 1.4; organic matter 2.5.

Carbonate of lime will not dissolve in pure water, but will dissolve in water that contains carbonic-acid gas. It becomes insoluble, and is precipitated as a solid form when the water is heated to a temperature of about 212 deg. F.

Sulphate of lime dissolves readily in cold water, but not in hot water. It precipitates in a solid form when the water is heated to a temperature of about 290 deg. F.

Chloride of sodium will not be precipitated by the action of heat unless the water contains a large quantity of it. In sea water, it is present in such great proportions that the use of sea water for boilers is precluded. This substance forms the greater part of the scale found in the boilers of ocean-going ships as it can be removed only by mechanical means.

Chloride of magnesium is one of the worst impurities found in water intended for boiler use. It renders the water corrosive when hot, and dangerously corrosive when present in large quantities.

Carbonates and sulphates of magnesium are not any troublesome constituents of feed water.

Organic matter by itself may or may not cause the water to become corrosive, and small quantities may be beneficial in keeping the scale from becoming hard.

Acids such as sulphuric, tannic, acetic, and nitric are sometimes present in water taken from rivers. Sulphuric is the worst, and will cause corrosion.

Oil and grease in the feed water carried into boilers are liable to do much harm, as they seem to combine mechanically with the other impurities, forming a loose

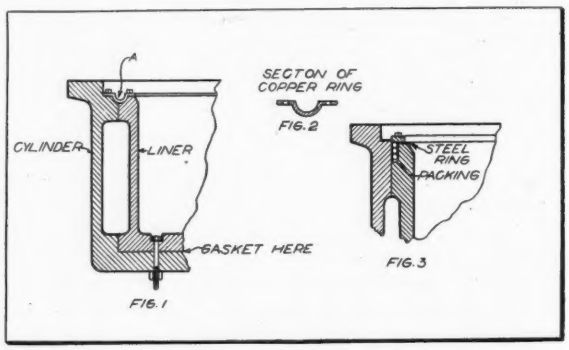


FIG. 1. SECTION OF CYLINDER SHOWING LINER CONSTRUCTION
FIG. 2. COPPER RING SHOWN AT A, FIG. 1
FIG. 3. SHOWING STEEL RING PACKING

spongy mass, and are liable to cause overheating of the plates. In modern practice, it is possible to precipitate the carbonates and sulphates of lime, organic matter and also the oil and grease, and they may be blown out as sludge. The principal impurities left behind then are chlorides of sodium and magnesium.

3. Ordinary sea water contains on an average 1 part solid matter in each 32 parts of water. As more water is supplied to the boiler and evaporated into steam, it is evident that in order to keep the contained solid matter within a certain limit, the water must be changed at intervals. The degree of saturation is the pounds of solids present, and is usually expressed as a fraction, for instance, 1/32 saturation means that there is 1 lb. of solid matter present in every 32 lb. of water. At 12/32 saturation water becomes saturated, and will not dis-

solve any more solids. The limit of saturation in boiler water is about 5/32. Less scale forming matter is carried into the boiler at this density than at a lower one, as less raw water is used. Furthermore, at this density there is sufficient difference between the specific gravity of the oil and grease carried in with the feed, even in the presence of carbonates of lime, with which it combines, and that of the water in the boiler, to insure the oil floating on top where it may be blown off with the surface blowoff. It is evident that the density of the water increases with the amount of solid matter dissolved therein, and consequently by measuring the density of the water the amount of solid in it can be determined; this is done by means of a hydrometer or salinometer as it is sometimes called.

To test the water, a tall tube is filled with the water from the boiler and the hydrometer placed in it with the heavy end down. The instrument will sink to a part of its depth, depending on the density of the water, and the density is read at the level of the water on a scale which is placed on the inside of the tube. The hydrometer is tested at a certain temperature, usually 60 deg. F., and the water should be at that temperature when tested. Frequent tests of the water will show when it has reached the predetermined limit of saturation.

4. It is sometimes the case that in fire-tube boilers with strong natural draft or with forced draft, the gases of combustion enter the stack at a high temperature, and the heat they contain which should have been absorbed by the water to make steam is wasted. In order to overcome this loss, and to cause the gases to be retained longer in contact with the tubes and therein utilize more of the heat, a retarder is placed in each tube. This retarder consists of a thin piece of sheet steel about ⅛ in. thick, the width of which is equal to the inside diameter of the tube. This metal strip is twisted to a spiral form, not unlike a carpenter's auger, and placed in the tube wherein it is a loose fit. This spiral strip causes the hot gases to take a spiral course through the tube, thereby increasing the distance they have to travel and keeping them in contact with the tube for a longer time, which gives the heat a better opportunity to enter the water. The retarder may be easily removed with a pair of tongs when it is necessary to scrape the soot out of the tubes.

A description of many of the new inventions in marine engineering may be found in the International Marine Engineer magazine, back copies of which can probably be found at any public library. I would suggest that you write to J. H. Colwell, Patent Examiner, Patent Office, Washington, D. C., who is the patent examiner in marine engineering, and he probably can furnish complete information on this matter.

J. C. HAWKINS.

Massachusetts Examination Questions and Answers

IN A third class engineer's examination, recently, an applicant was asked the following, and received a license by the answers given; so here is a chance for someone to brush up, free of charge. Remember, just a sweeping glance over these will do you no good. You must study, understand them thoroughly and make sure you can answer each question without referring to the written answers; that is, if you are really interested in a Massachusetts license.

1. If you were to look at a feed water heater and the pump connections were concealed, how could you tell whether steam or water was going through the tubes?

2. If something happened to your engine and it was put out of order so it could not run, and you had no way of getting the engine on the center, how could you set the valve?

3. Why are the water valves in a pump put in so that it is difficult to get at them for repairs?

4. How can you tell the direct from the indirect side of a pump?

5. What kind of an engine valve is an indirect valve?

6. Would a piston valve taking steam at the center, be called an indirect valve?

7. Taking a new engine before setting up, how can you tell what the clearance will be?

8. If the crankpin on an engine is heating up, is there any way except by the lubricator, that you can ease up on it without shutting down?

9. If you have a load on an engine running on a jet condenser, and you wish to shift this load onto another engine running on a surface condenser, both of which take water from the same source, how would you do so without dropping the load, or losing the vacuum?

10. If you key up on both ends of a connecting rod having solid ends, will it make any difference to the clearance?

11. How would you know if you have a leak in the tubes of a heater, and how could you be sure the pump was not out of order instead of the heater?

12. Suppose in a Webster or Paul system of vacuum heating, the vacuum should drop from 10 to 5 in., with the circulation water at the same temperature, all in good condition, no leaks in the system, what would be the matter?

13. On a triple expansion engine, how would you find the terminal pressure of the low-pressure cylinder?

14. If the fusible plug gives out, where would the water fall in the fire-box?

15. What is the function of a flywheel on an engine?

A. You could tell by feeling of the pump and heater. If steam was going through the tubes, the heater would cool off.

2. There are, on most engines, marks by which to set the valves, and you can adjust valves temporarily, if not accurately, by means of these marks.

3. The water valves are not built in a pump so that it is difficult to get at them. They are placed close to the bottom chamber, where a good volume of water can be conveniently and easily forced or sucked through the valves.

4. In a duplex pump, one of the valve stems is operated indirectly by the rocker arm. That is the indirect side of the pump; the other is the direct side.

5. An indirect engine valve may be one where the steam does not enter the main valve directly, but through some intermediate passage.

6. A piston valve taking steam at the center, may be a direct valve, for the steam enters the main valve

directly. If the steam passed through a hollow piston first, into another compartment, before entering the main valve, it could be called an indirect valve.

7. The high-speed engine with its relatively short stroke must necessarily have greater clearance than the releasing valve type engine of long stroke. In one case, the clearance will vary from 8 to 12 per cent of the piston displacement, and in the other, from 2 to 3 per cent. To find the clearance, take out one of the indicator plugs and fill the clearance space full of water. Draw off the water through the cylinder cock and measure it, which will give you the number of cubic inches contained in the clearance space.

8. Use some cooling liquid.

9. You must first start up your pump and get your vacuum in the surface condenser; then start up the engine, and when everything is in the same condition on this engine as it is on the one which is running, change over the load.

10. It would make no difference to the clearance by keying up on a solid end connecting rod. If you change the distance between the crankpin and the wristpin, you change the clearance.

11. If you had a leak in the tubes of your heater, the water would be cooling off the steam, and condensing it rapidly, while the heater would cool off. Feeling of it would instantly reveal this fact. You could tell in the same manner if the pump was not working.

12. To this question, I affirm that the air pump must be out of order, either drawing air through a leak or, possibly, the packing is worn in the air pump.

13. The total number of expansions is determined by the ratio between the initial absolute pressure in the high-pressure cylinder and the terminal pressure in the low, irrespective of the number of cylinders employed. Having the initial pressure given, then decide upon the best terminal pressure, dividing the absolute initial pressure by the absolute terminal pressure, thus obtaining the total number of expansions.

14. If the fusible plug gives out, the water in a locomotive boiler will squirt, spout or spray on top of the fire in the fire-box.

15. The flywheel is used to get momentum in carrying the engine and the load over the dead center.

LUKE MARIER.

Steam Condenser and Indicator Card

KINDLY GIVE me your opinion of the enclosed indicator card which was taken from an 11 by 24-in. Corliss engine running at 102 r.p.m.

I desire to know if it would pay to draw a vacuum on our steam condenser. This is an atmospheric condenser consisting of a 2-in. pipe 9 ft. high, connected by a 4-in. line to the various exhaust lines, while pure water leaves the coil through a 1¼-in. pipe and flows into a reboiler.

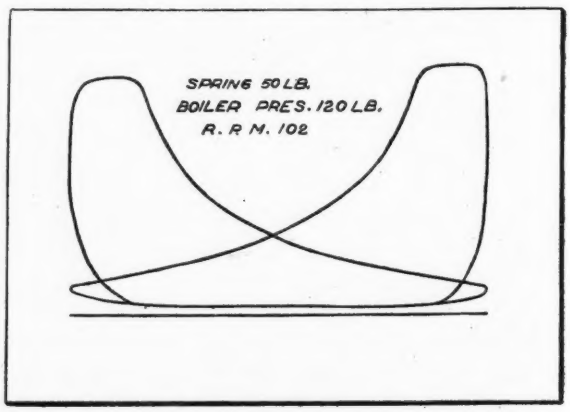
We have a 6 by 5 by 8-in. duplex pump which I could employ to draw a vacuum. Or would it be best to run a water line from the pump and use a jet?

I. B. F.

A. In answering the steam condenser question we must begin by asking another question. Have you too much distilled water? When running an engine condensing, it is a known fact that less steam is used and consequently less water made. If the condensing engine is used, there is no question as to what kind of condenser to install. It must be of the surface type, as the jet is impossible if the condensed steam is to be used for ice making.

I have handled a vacuum distilling system, but it was in a plant that had a large cold storage and the ice making was of secondary consideration. Owing to the power required for the cold storage, we had more than enough distilled water. Both ice machines and the light and power units were cross-compound condensing.

Surface type condensers are necessary, as is also a dry vacuum pump, and I am of the opinion that the cost of reboiling is greater than in a common noncondensing plant. The gases have no chance to escape and the vacuum pump does not take them away.



INDICATOR CARD OF 11 BY 24-IN. CORLISS ENGINE

With a simple Corliss engine I am sure that the atmospheric type steam condenser will give the best results for an ice plant. Have enough condensing surface and keep the condenser clean. Keep just enough back pressure so that the white flag is always visible at the gas reliefs and no more.

In conclusion, I will say that it will not pay you to install a vacuum system from what information I can gather from your letter. The vacuum system is rather complicated and requires 10 times as much attention as the atmospheric. Do not install any new apparatus till you are positive that it will pay for itself and also pay a paying percentage on the investment.

A surface type steam condenser is hard to keep free from scale and in most cases the condenser must be cut out of service while cleaning the tubes. If the water is bad and causes much scale formation, the expense of boring out the tubes will be great.

The indicator card is rather good. The steam valve on the head end (left diagram) is a little late and also the compression on the same end is rather too great.

It seems to me that the engine runs rather fast for driving an ice machine; but I might be mistaken, as I do not know the conditions.

A. G. SOLOMON.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Difficulty with Boiler Tubes; Amount of Current

I SHOULD like to hear, through the columns of Practical Engineer, from engineers in charge of both coal and oil fired boilers, their experiences in cases of tubes splitting or blowing out; how they handled the difficulty, maintained water, etc.

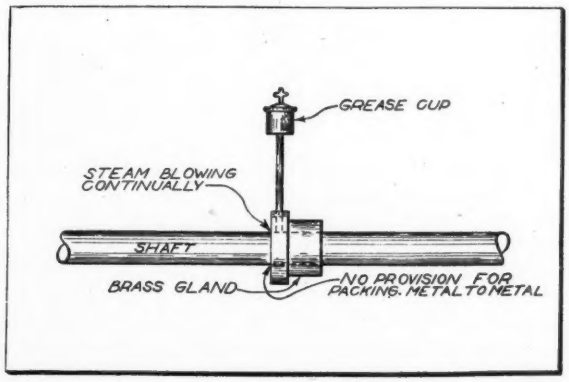
Is there any particular point on the shaft for keyways; that is, in regard to the crank in line with it or on the quarter?

What is the amount of current in amperes, used by the different types of lamps on a 110-volt circuit?

F. T. S.

Leaky Stuffing Box

IN A TURBINE which I am operating the steam stuffing box on the shaft is a metal to metal fit with no provision for packing of any sort. There are grease cups for



METAL TO METAL STUFFING BOX CAUSING EXCESS LEAKING OF STEAM

lubrication, but the steam blows through continually. Have any readers suggestions to offer of a remedy for the trouble? M. L.

Compressor Trouble

I AM in charge of a cold storage plant, in which there are 2 6-ton York machines. I make about 1000 lb. of ice a day, and have 6 small rooms to keep cool. They kill on an average about 10 head of cattle, 5 hogs and 10 sheep a day, that being all which is required of the 2 machines.

The head pressure is 190 lb., and the back pressure is 20 lb. The discharge is so hot that it cannot be touched, and if I frost clear back to the machine, the condenser pressure goes still higher, and discharges as hot as ever.

I would appreciate any information you can give me on this subject. L. E. M.

Cylinder Oil in Boilers

IN REGARD to the questions of B. S. C., published in the July 1 issue, I would like to state that rivets will leak before tubes. Tubes as a rule do not develop leaks due to overheating, but on account of the presence of oil between the tube and plate. To avoid such leaks almost all boiler makers use soap water when drilling instead of oil.

2. If a boiler contains grease and oil, get inside, and by means of a stiff wire brush go over every part of it within reach. Having done so, wash off all stays, tubes, heads and sheets with kerosene, after which flush out with a liberal supply of water.

Replace front and rear manhole plates, fill boiler up to braces with water containing 50 or 60 lb. of soda ash, boil boiler out for 2 or 3 days and as the water evaporates add more of the solution. Then empty boiler and wash out thoroughly. Repeat this operation and your oil and grease will disappear.

While kerosene may cut the oil better than the soda, it is far more dangerous, as it will cause leaks in tube ends, at rivets in girth seams and will cut rubber gaskets.

3. Try lubricating your cylinders with kerosene, using care not to feed any more than is absolutely necessary, as it may cause leaks in joints although I would prefer having leaks to bagged boilers. If kerosene will not do for this purpose, use the best grade of cylinder oil on the market and put a good separator and trap on your exhaust line.

As a suggestion I would advise filing off any sharp edges which may be on the valves, seats or piston rings.

If possible, do not use your return water, but should it be necessary to do so, place an oil extractor on your feed line.

Put in bypasses on your separator, trap and oil extractor so as to enable you to remove any one of them in case of necessity without interfering with the operation of the plant.

When feeding soda to your boiler, do not use too much and be sure to keep the water level comparatively low so as to avoid foaming, and blow down boiler 1 gage, 3 times a day.

I have been able to put 2 lb. of soda a day in each boiler but was careful not to force the boilers or carry more than 2 gages of water. C. M.

ARE YOU ANXIOUS to have the real joy of living? Then, in your youth, your growing time, get ready: First, to wrest from this world an adequate return for good workmanship; second, to cultivate the powers of appreciating the best things in life; third, to crown possession and appreciation, with the gift of gifts, Contributing Power.—La Salle Magazine.

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Getting Rid of Oil

It is generally conceded that lubricating oil in boilers is dirt, that is it is "matter out of place." Even those who advocate the use of kerosene as a remedy for scale, will hardly advise the use of cylinder oil for a like purpose. It, therefore, becomes a matter of interest to keep oil out of boilers and to understand why this is a difficult problem. R. Basil Barham, in Mechanical World, brings up some interesting facts, and some opinions that seem open to debate.

Hot lubricating oil is so thinned that it falls to the bottom of the cylinder and mostly escapes with the exhaust, partly as vapor, for the lighter hydrocarbons will be vaporized at the heat of steam, partly as fine spray or as a coating to globules of water. That part which is a vapor can hardly be removed by a mechanical separator, but must be condensed, either with the steam or separately, while the oil spray and globules of oil and water may be caught on baffles and washed down to a receiver. Some oil will, therefore, reach the condenser, and usually so intimately mixed with the water that removal is extremely difficult.

Part can be separated by permitting the condensate to stand so that the oil will rise and can be skimmed off, but this rising of oil is slow and may go on for months before the separation is complete.

Centrifugal force may be used to hasten the separation as in a cream separator, and this treatment, followed by filtering of the oil and water is claimed to leave both in the best of condition for reusing.

It has been discovered also that the oil globules in the emulsion are negatively charged with electricity, hence they can be thrown out of the mixture by means of some solution whose particles are positively charged, such as hydroxide of iron. Also a method of electrolysis can be used, passing the condensate between iron electrodes and adding carbonate of soda to raise the conductivity. An alkaline salt is formed at the cathode and the oil globules become mixed with this and are retained in the precipitate which can be filtered out from the water. The filtering should take place some time after the electrolytic treatment in order to allow all the precipitate to settle out.

Costs are given as small, since to treat 1000 gal. an hour requires only 1.75 amp., which at 230 volts would be 227 w.-hr. For 1000 gal., the sodium carbonate required is 1.5 lb., which would cost about 2 cents, while the cost of current would be about 1 cent at most.

While it seems from tests that settling and filtration can remove oil to the point where it gives little if any trouble in boilers, it would seem that the speed and cheapness of the electrolytic treatment make that method worthy of wider use than it now has.

THE MOUNTAINS OF CULM or coal waste which break the skyline throughout the anthracite coal region of Pennylvania, and which were for many years considered a nuisance, are now being made to serve as fuel after being washed. Even the waste from the culm-bank washers is being utilized, for it is flushed into the mines and partly fills old workings where it cements together and furnishes support to the roof when the coal previously left for pillars is removed.

News Notes

On Sept. 1, Hess & Barker, Philadelphia, Pa., will occupy their new quarters at 236 S. 8th St.

William F. Lee, chief engineer of the C. W. Hunt Co., Inc., West New Brighton, S. I., N. Y., at a recent meeting of the board of directors, was elected vice-president and chief engineer of the company. Mr. Lee is well known in Greater New York engineering circles.

U. S. Civil Service Commission announces an examination for junior engineer (experimental plant and machine testing), on Sept. 2 and 3, 1914, to fill a vacancy in the Bureau of Chemistry, Department of Agriculture, at a salary ranging from $1200 to $1800 a year. Duties will consist of designing, constructing, and operating plants for experimental and demonstration purposes in the preparation of certain fruit and vegetable products, especially fruit and vegetable drying and refrigeration, the computing and compiling of technical and cost data on the operation of such plants; and a limited amount of mechanical drafting. It is desired to obtain the services of someone who has had experience in the design or operation of experimental plants, or who has had technical laboratory work along the lines of machine testing and refrigeration. The following subjects will have the relative weights indicated: Mechanics and dynamics of engineering, 25; technical engineering testing, 40; education and experience, 35. Applicants must have a mechanical or electrical engineering degree from a technical school of recognized standing, and 2 yr. practical experience, subsequent to graduation in an experimental laboratory or in machine testing. Applicants must have reached their twentieth but not their forty-fifth birthday on the date of the examination. In applying for this examination, ask for Form 1312, giving the title, Junior Engineer (Male).

To handle its increasing business in the northwest territory, the C & C Electric & Mfg. Co., of Garwood, N. J., manufacturer of electric motors, generators and electric arc welding equipments, announces the opening of a branch sales office in the Security Building, Minneapolis, Minn. This branch will be in charge of R. L. Wells.

John Simmons Co., of New York City, announces that it has taken over the manufacturing and selling rights of the Kebec water circulator formerly manufactured by the Klein Boiler Circulator Co., and has placed P. M. Klein in charge of this new department.

The Monongahela Valley Traction Co. recently purchased the machinery for its new power plant at Hutchinson, W. Va. It is believed that recent rains have solved the immediate troubles of the line and that the company will soon recover its reputation of strict reliability. Every indication points to usual service from this time on. According to advices from General Manager James O. Watson, his new purchases consist of 4 1250-kw. gas engines, 3 to be installed in 4 months and the others when needed. The three will be in operation by Dec. 10, and by that time the building will be ready for occupancy and current from the generators may be used for the movements of the cars and trains.

It is reported that an electric light plant is to be built at Dodge Center, Minn., in the near future. In addition to this, a high tension transmission line will also be erected to supply current to Hayfield, 14 mi. south, Claremont, 6 mi. west, and West Concord, 6 mi. north of Dodge Center.

Section 3 of the ordinance passed by the Town of Dodge Center granting the Iowa Minnesota Light and Power Co. free use of the streets, alleys and public places of the town for a period of 15 yr., for the purpose of installing, erecting, maintaining and using plants, towers, poles, lines and supports, contains a stipulation regulating the price to be charged for current and reads as follows:

Section 3. Said grantee under this Ordinance shall be permitted to charge and maintain rates for such current and service as follows for the kinds and classes of services herein specified, towit: For ordinary lighting service 12 cents per kw.-hr. with a sliding scale to 6 cents per kw.-hr., as may be fixed by the company from time to time for current used by each consumer in each month, with a minimum charge of $1 for current used in any one month, but the total charge for the first 100 kw. of electricity used under any one service in any one month shall not exceed $9.50.

For current furnished for the operation of motors to 1 hp. and under for each motor of each consumer, the maximum rate shall be the same as the lighting rate, that is, 12 cents per kw.-hr. on sliding scale to 6 cents, as aforesaid, and with a maximum charge of $1 per month for current used by one consumer under one meter, the minimum charge for both shall be $1 per month.

For current furnished for motors of capacity larger than 1 hp., the maximum rate shall be 8 cents per kw.-hr. for current used through each motor of each consumer, and with a minimum charge of current used through each motor by each consumer of 50 cents per hp. per month.

A flat service charge of 25 cents per month may be made on all services for lighting and of 25 cents per month for each motor of 1 hp. or under and of 50 cents per month for each motor of capacity greater than 1 hp., and this in addition to the lighting or motor metered current or minimum charges as above provided. It is also provided, however, that if the amount due for current service for the preceding month, together with any arrearages that may be due from such consumer shall be paid by the 10th of the month following that in which the current was used at such place as may be from time to time designated by the said company such flat charges shall be discounted.

Correction Notice

In the article "Pop Safety Valve Formulas," page 737, July 15 issue, a typographical error appears. Formula (or rule) No. 2—that of Philadelphia—should read as follows:

$$A = \frac{22.5 \times G}{BP + 8.62} \quad \text{Philadelphia}$$

The article is an exact reprint from the Valve World and the correction comes through the same source.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Ray Continuous Feed Water Regulator

THE feed water regulator shown in Fig. 1, is a new device for giving a continuous feed of water to boiler in exact ratio to evaporation, and how simply it will accomplish this result will be evident to everyone at a glance. The water column, float chamber and feed valve are all combined in one piece, resulting in a saving in first cost and a great reduction in the number of parts to be maintained.

Number 11 is the regulator body of water column and is made right or left-hand, both for the gage cocks

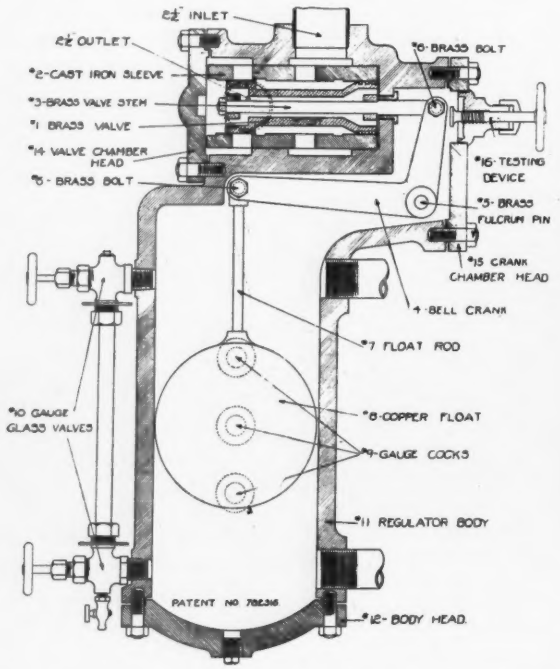


FIG. 1. SECTIONAL VIEW OF RAY CONTINUOUS FEED WATER REGULATOR

and the water outlet. In the valve chamber at the top, a cast-iron sleeve, 2, is fitted, into which a brass piston valve works. This sleeve has inlet and outlet ports cut through for the passage of the water from the feed line to the boiler. The piston valve, 1, is operated through bell crank, 4, and connections by a copper float, 8. If for any reason the regulator should fail to work or need to be cut out of service, it can be quickly done by screwing in of testing device, 16, which will force the valve wide open and hold it wide open. This same device can be used for testing the regulator at any time, especially after being out of service for some time. Gage cocks, 9, and water gage glass valves, 10, are also a part of the regulator equipment and a high and low water alarm can be applied if desired. The float, 9, is protected at all points where wear may take place.

This regulator consumes no steam or water in its operation and works independent of the pressure in the boiler or in the supply pipe to the regulator, the regulator valves being perfectly balanced both ways. All parts are easily accessible and are interchangeable, all being made to template.

Operation is as follows: Suppose that a boiler is started up and cut in on the line, then as soon as the evaporation begins, the float falls and valve opens and water is admitted to the boiler in exact ratio to the evaporation. If it were possible to maintain an even

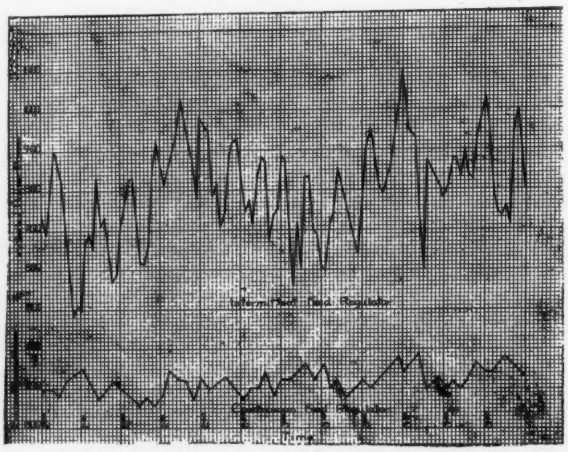


FIG. 2. DIFFERENCE IN CONTINUITY OF OUTPUT

temperature under the boiler, then the diagram of boiler output would be a straight line and would continue so for an indefinite period; but owing to the variation in furnace conditions, it will not be possible to get an absolutely straight line output from any boiler. The valve, 1, and sleeve, 2, may be made several sizes, depending on the size of the boiler. The valve and sleeve as shown were designed for a 500-hp. boiler and under test 1500 hp. of water was passed, giving a 300 per cent rating and showing large overload capacity. A water pressure is maintained on feed piping up to regulator by a pump governor of about 40 lb. in excess of boiler pressure, so that there will always be a supply of water up to regulator.

From no load up to full maximum output of the boiler, there will be a fall of water in the glass of 2½

in., but under normal constant output there will be no change in level. This variation in height is not a detriment, but rather a valuable asset, for with a light load on the boiler the water will go to the highest point; then when a heavy load comes on, the heat that is stored up is given up to carry over that period while the furnace is changing to meet the new conditions. When load decreases, the water rises again and heat is stored and ready for the next change in conditions.

Figure 2 shows the vast difference in continuity of output when using the 2 types of regulators, the upper line was made while using the intermittent type of regulator and the lower line while using the continuous feed type.

A continuous feed water regulator, such as shown above, will give results as follows:

Dry steam at all times; more constant superheat; efficiency of feed water heater will be improved; less expansion strains on boiler; measuring of feed water made possible by the eliminations of fluctuations in flow of water.

This regulator is manufactured by the Ray Manufacturing Co., 1033 Edwards Ave., Louisville, Ky.

New High Voltage Outdoor Oil Switch

WHILE the general principle of operation of outdoor oil switches is identical with that of the indoor type, the details of construction differ to a marked extent. In addition to performing the usual duties, the outdoor switch must be so constructed that successful service will result while exposed to the effects of the severest weather, and neither rain, snow nor sleet should be able to interfere with its satisfactory operation, a result which can be accomplished only by totally enclosing and fully protecting all moving and operating parts.

Illustrated herewith are 2 Type F, Form K-22 outdoor oil switches as manufactured by the General Electric Co. They are built in single-pole elements, operated by hand, solenoid or air, the mechanism for each element being self-contained and mounted on the top of a steel tank. The switches trip independent of the operating mechanism, so that the automatic switches cannot be held closed on overload or short circuits, and all the switches, automatic or nonautomatic, are always closed at the same quick rate of speed.

Since the insulating properties of oil are superior to those of air, the insulating bushings are inserted through the cover at an angle converging at the lower end, which materially reduces the size of the oil tank necessary for any given voltage. The bushings, which are supported by metal clamps bolted to the tank cover and may easily be removed for inspection and repair, extend below the oil level down to the stationary contacts of the switch.

Contacts of the sliding wedge construction are used, the stationary ones consisting of widely flared fingers and extra long arcing tips of drop forged copper, while the movable element is a wedge shaped copper blade. This blade moves in a vertical plane, being drawn up by the switch mechanism when the switch is closed and dropped by gravity, assisted by springs when the switch opens. By the use of the sliding wedge contact, the arcing set up by opening the switch under load occurs between the extended portion of the stationary contact fingers and the upper extremity of the movable blade, which sections are not in contact when the switch is fully closed.

FIG. 1. TYPE F, FORM K-22, TRIPLE-POLE, SINGLE-THROW, 22,000-VOLT OUTDOOR OIL SWITCH

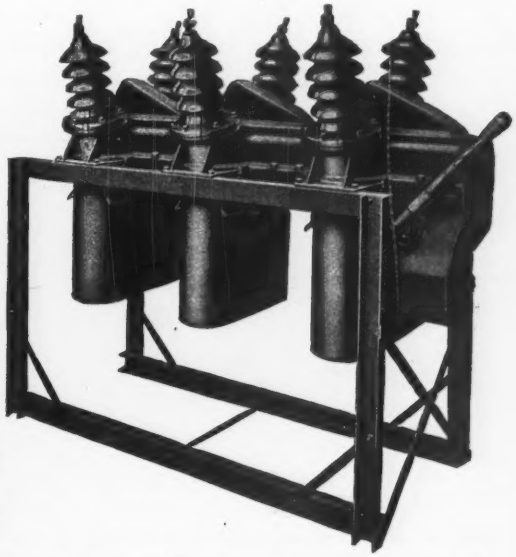


FIG. 2. TYPE F, FORM K-22, TRIPLE-POLE, SINGLE-THROW, 130,000-VOLT OUTDOOR OIL SWITCH

The switches are as a rule tripped on overload by trip coils acting directly on the switch toggle and operated by bushing type of transformers, although the other methods of tripping oil switches in general use can, of course, be applied.

Large Double Disc, Parellel Seat Gate Valve

ON July 15, 15 days earlier than their contract stipulated, Pratt & Cady Co., Inc., of Hartford, Conn., delivered to the Filtration Department of the Cleveland Water Works of Cleveland, Ohio, 4 60-in., double-disc, parallel-seat gate valves, shown in Fig. 1, which are to lie on their sides on a horizontal pipe line and control water at a pressure of 10 lb. per sq. in. Each valve measures 13 ft. 6 in. in length, 6 ft. in height and 3 ft. from face to face of flanges, and will be operated from above through a floor-stand by means of a 5-hp., 220-v. motor attached to the floor-stand.

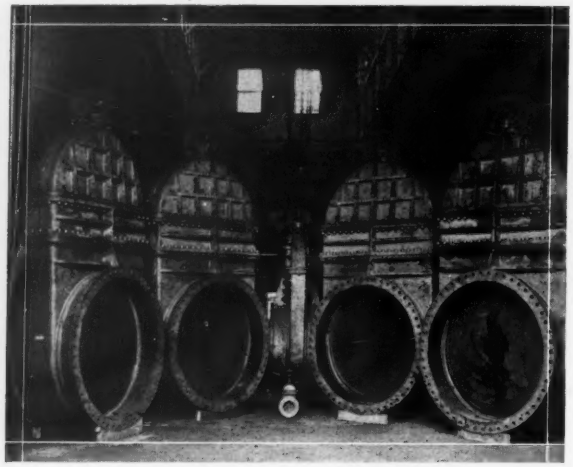


FIG. 1. 4 60-IN. GATE VALVES BUILT BY PRATT & CADY CO., INC., FOR THE CLEVELAND WATER DEPARTMENT

In addition to these 4 60-in. valves, there were included in this contract 6 36-in. valves of the same general type operated by 2½-hp. motors on floor-stands

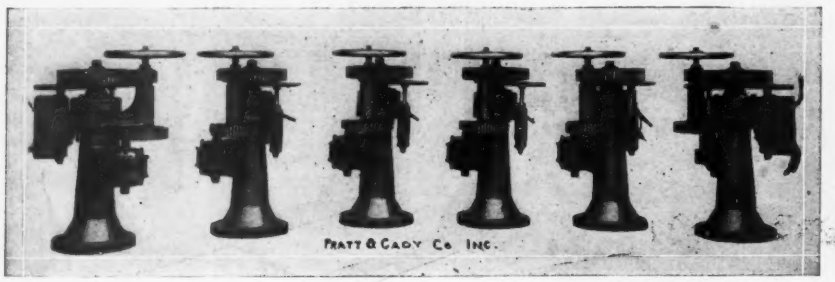


FIG. 2. FLOOR STANDS, MOTOR OPERATED, FOR LARGE PRATT & CADY GATE VALVES

and 1 48-in. valve operated by a 5-hp. motor mounted on the valve bonnet. This 48-in. valve will stand upright on a horizontal pipe line.

U. S. CIVIL SERVICE COMMISSION announces an examination, on Sept. 8, 1914, to fill a vacancy in the office of the Superintendent of Radio Service at the Naval Radio Station, Radio, Va., at a salary of $10 a day. Apply for Form 304, giving the title, Expert Radio Aid (Male) (Administration and Operation).

Pyro-Perolin Boiler Cleaning

TO remove scale from a boiler quickly and entirely, and thereafter to maintain the surfaces free from deposit is a much sought result which long baffled human ingenuity. Scale in a boiler is a certain cause of loss in efficiency, hence the great cost which will be borne, if necessary, to get rid of it.

Perolin, a treatment for boiler metal to prevent scale adherence and to separate scale already formed, from the metal, has proved its efficiency in many plants, as is fully attested by the records of the Perolin Co. of America, and by letters received from users. The action is due to 3 properties of the Perolin: 1, it is diffused through the water in the boiler, not dissolved, so that it reaches all metal surfaces; 2, it has affinity for the metal so that it forms a protecting film on the free surfaces and creeps in between the metal and adhering scale; 3, it expands when heated, thus separating the scale from the metal.

To this effective system is now added the Pyro-Perolin process for quick removal of scale accumulations. Scale is first treated with Perolin so that all parts of the boiler are permeated. A special apparatus generating and combining various gases is then used, the combined gases being ignited and used through a special burner for heating the scale which is completely decomposed by the action of the Perolin and the gases and reduced to a powder, leaving the metal bare and clean, even in parts which might be inaccessible to mechanical processes of removal. The combustion is such that the Peroline Co. guarantees no injury to the metal or tubes.

FIG. 3. 48-IN. GATE VALVE BUILT BY PRATT & CADY CO., INC., FOR THE CLEVELAND WATER DEPARTMENT

Cleaning a boiler by this process requires only 1 to 3 days' time, depending upon its size, condition and type, after which a liquid protective, heat-conducting film is applied which fills the pores of the metal and establishes a smooth surface over the entire boiler to which scale-forming sediment cannot adhere as long as

this film is maintained by a small daily feed of Perolin German Boiler Metal Treatment. Boilers are cleaned by this process and the film applied and maintained at a definite cost, so that the plant engineer knows positively what the expense will be per year to maintain clean boilers.

The Perolin Co. of America, with offices in the Woolworth Bldg., New York, and whose factory and general offices are at 1112 West 37th St., is contracting to clean boilers of a plant by the Pyro-Perolin process, applying a Perolin protective film and agreeing to maintain the boilers in this clean and scale-free condition at a definite charge.

The contract furthermore provides that should scale again form, the Company will reclean such boiler, or boilers, with the Pyro-Perolin process without any charge whatever throughout the life of the agreement. This contract is backed up by surety bond guaranteeing fulfillment of the contract and also protecting the plant against any and all damage to the boilers or boiler metal, as well as to the property or employes, and still further guarantees that in case the Perolin should fail to keep the boilers clean and the Company should refuse to reclean them at no expense, the plant owner has the right to have the boiler, or boilers cleaned in any way or manner whatsoever he may see fit at the expense of the insurance company.

This proposition has never before been offered to plants of America, although this same process has been used for some time throughout the countries of Europe, especially in Germany and England.

The Perolin Co. has an organization covering the entire United States with 28 sales offices and has planned to have a complete service station at each of these sales centers to take care quickly of the work in the respective territories. Also the Company has a complete Engineering Efficiency Department at each of its main offices in New York and Chicago, composed of expert engineers on power plant efficiency for the exclusive use of its customers to give without charge information and assistance on any power plant engineering problem.

Guarantees, as set forth in the contract, are: First, to clean any type or size of boiler by the use of the Pyro-Perolin process and deliver it, free from scale in all parts of the boiler, within 1 to 4 days, according to the size and conditions of the boiler. Second, that by this process there will be no damage done to the metal of the boiler or to its setting or attachments, subject to the inspection and approval of the boiler insurance companies. Third, to keep the boiler free from scale indefinitely as long as the Perolin German Boiler Metal Treatment is used as directed, thereby keeping the boiler up to its full rated capacity. Fourth, to protect the boiler metal against pitting, corrosion and galvanic action, regardless of the kind of water used. Fifth, to correct troubles caused by oil and grease getting into the boiler. Sixth, that the treatment will not affect or impart any off-odor to steam or distilled water or affect in any way the products of breweries, ice plants, dye works or other industries using live steam for cooking or manufacturing. Seventh, to reclean the boilers without charge if the daily feed of Perolin fails to keep them free from scale at any time during the life of the agreement.

Swing Gate and Check Valve Applications

USES IN MIXED FLOW TURBINE PLANTS FOR BACK PRESSURE, RELIEF AND NONRETURN. BY OSCAR C. SCHMIDT

AN increasing and promising use for the steam turbine is its application as a secondary or low-pressure unit in connection with noncondensing or condensing engines, or, combined with a regenerator, in connection with engines using steam intermittently.

At first, the most promising application of the low-pressure turbine was to use steam from inefficient noncondensing engines which were found in steel mills and mine hoists; but its field of employment is now extended to efficient power engines in railway and lighting plants, as it has been thoroughly established that a most efficient arrangement of steam plant consists of a compound unit consisting of a reciprocating engine, acting between boiler pressure and approximately atmospheric pressure, and a low-pressure turbine which discharges into a condenser.

It was not until the low-pressure turbine had been commercially developed that engineers fully realized the significance of the fact that the available energy per pound of steam, between 150 lb. boiler pressure and 28 in. vacuum, was cut practically in halves by the line of atmospheric pressure.

Reciprocating engines are incapable of utilizing most efficiently the energy below the atmospheric line, for to attain the proper degree of expansion requires an enormous cylinder, the friction within which would consume a large portion of the available energy. The turbine, however, can utilize the energy between 26 and 28 in. of vacuum as effectively as it can utilize the energy between atmospheric pressure and 5 lb. below.

The mixed turbine plant therefore gives excellent steam economy over wide ranges of load; it gives considerable elasticity of operation due to the fact that either engine or turbine may be operated separately; any leakage in the engine due to leaky valves, and improper valve setting is taken care of by utilizing that steam in the turbine; and where exhaust steam is used for heating, the mixed turbine plant allows the required amount of heat to be diverted for heating purposes before the steam enters the turbine.

The principal difficulty which must be solved in the practical design of mixed flow turbines, is the method of regulation, so as to allow the use of all the exhaust steam available, after which any deficiency in the low-pressure steam supply can be made up by high-pressure steam.

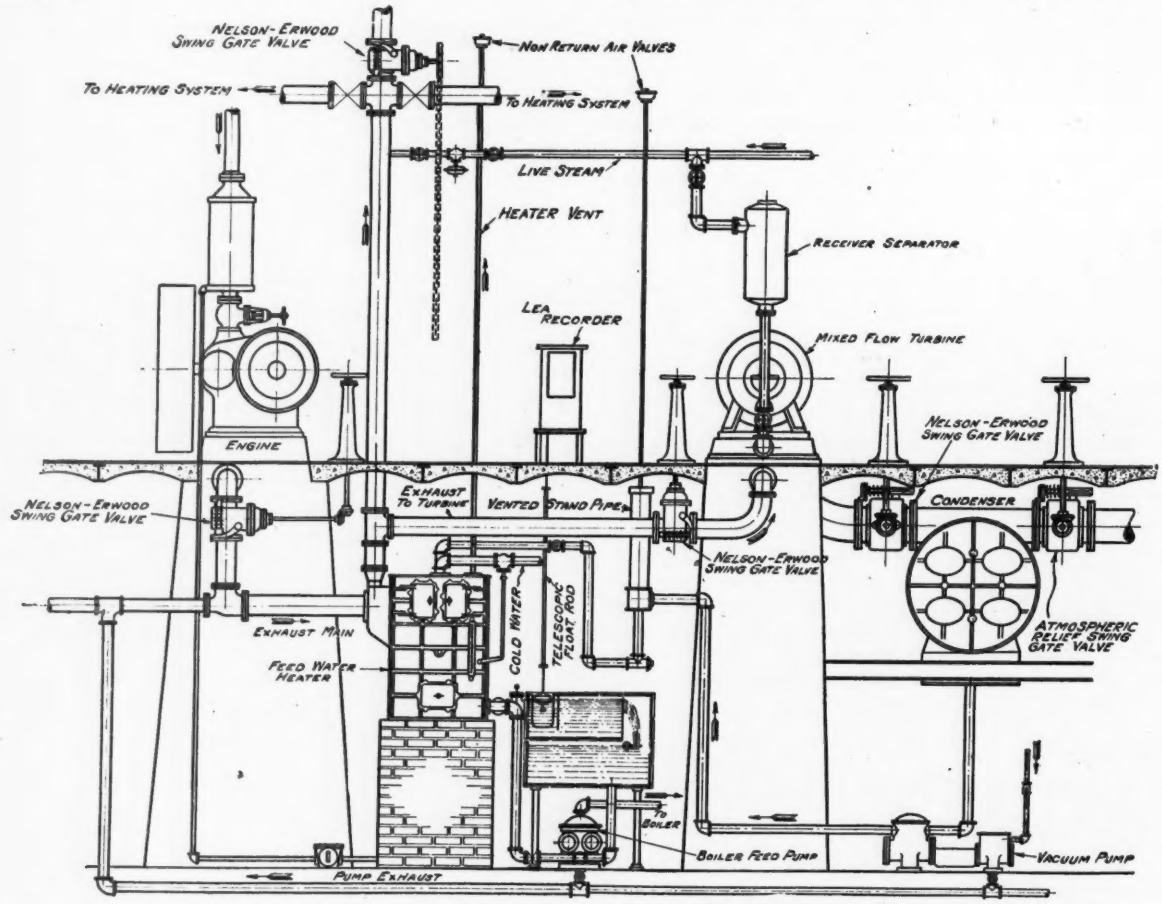
In order to obtain the proper efficiency of the turbine under the usual operating conditions, 2 methods are used. The first consists of having a turbine so constructed that the high-pressure steam is admitted automatically through an auxiliary high-pressure section of the turbine. In this case, the high-pressure steam goes through the high-pressure portion of the turbine and after the steam has been expanded to practically atmospheric pressure, it enters the low-pressure part of the turbine, in which it expands down to the pressure in the condenser. When low-pressure steam is admitted to the turbine, it enters the low-pressure section of the turbine only. When running as a low-pressure turbine, the

high-pressure blades will be revolving idle. The second method consists in utilizing high and low-pressure steam on the same turbine wheels, the steam acting on the same buckets in both cases. The low-pressure steam is admitted through one set of nozzles and the high-pressure steam through another set, the nozzles being so designed as to expand the steam from either source properly.

Whichever system of steam distribution is used, it is important that the piping be of proper design, and that both the engine and turbine units be protected by means of the proper safety devices, so that no damage be done, if the condenser floods, if the wrong valves are manipulated at the wrong time, or if the valves are not operated in their proper order when starting and stopping.

the steam flows from the boiler into the engine, then through the turbine and into the condenser. If there is not enough exhaust steam coming from the engine to operate the turbine unit, live steam may be admitted to it as shown, or if too much exhaust steam is flowing toward the turbine, a portion of it may be diverted to flow into the feed water heater, and a proper amount of steam may be used from the engine exhaust to supply the heating system when conditions require. Such a combination of piping as shown makes for flexibility of operation under all conditions of service.

Under all these conditions of operation, the combined swing gate and check valves, when placed in their proper position on the pipe, operate normally as an ordinary stop valve; but, in addition, they protect the power plant



USE OF SWING GATE AND CHECK VALVES IN MIXED TURBINE PLANT

In order to allow the engine and turbine unit to operate safely under all conditions, the Nelson-Erwood Swing Gate and Check Valve has been used extensively. This type of valve acts as a safety valve on any pipe line where it is necessary that the flow through the pipe shall be in one direction and where disastrous effects would follow if the steam or condensate was allowed to flow into the engine or turbine in a direction contrary to that for which it was designed. The general arrangement of piping for a mixed turbine and engine plant is shown in the accompanying illustration.

When all the steam is used by the operating units, should conditions change without the knowledge of the operator. For instance, if the engine is started, without opening the valve on the exhaust, the swing gate check valve will open automatically at a predetermined back-pressure on the engine and stay open until it is mechanically closed by means of the hand wheel attached to the valve stem as in an ordinary gate valve.

When the exhaust steam from the engine is used for the heating system, this swing gate and check valve is used on the atmospheric exhaust pipe as a back-pressure valve. When high pressure is used for the turbine, any excess of pressure in the turbine, above the back pressure

in the engine, is prevented from affecting the engine by the swing gate valve closing automatically. When the pressure on the turbine side decreases, the valve will allow exhaust steam to flow to the turbine in the usual manner. As applied to the condenser piping, the swing-gate valve will prevent flooding of the turbine due to loss of vacuum and also acts as an atmospheric relief valve.

All of the protective and operating features of the swing gate valve are based upon the fact that it is constructed as a gate and check valve in one, and is capable of performing the functions of either. The checking action of the swing gate is controlled outside of the valve casing, according to the pressure desired, and further action of the gate is controlled by the hand-wheel, which raises the gate above the valve opening exactly like an ordinary gate valve, thus giving a full, unrestricted opening.

The valve is always positive in its action, as the flat bronze gate and seat ring are constantly cleaned by the raising and lowering of the gate, which wipes or shears off any foreign matter which would otherwise interfere with perfect closing.

Catalog Notes

LATEST TYPES of Canton-Hughes simplex and duplex boiler feed pumps are illustrated in a folder from The Canton-Hughes Pump Co., Wooster, Ohio.

A PAMPHLET FROM The De Laval Separator Co., New York, Chicago, etc., deals with De Laval oil reclaiming centrifugals for handling exhaust steam condensate.

ERIE PUMP AND ENGINE WORKS, Erie, Pa., has issued bulletins as follows: Bulletin No. 29, on Erie Class L Low Head Centrifugal Pumps; No. 30, on Erie Sand Gravel Dredging Pumps; Erie High Duty Centrifugal Pumps.

VOLUME 1, NO. 2, of the Journal of the American Water Works Association is received, this journal now being published quarterly, from the secretary's office at 47 State St., Troy, N. Y. An important feature of the issue is the report of the committee on the Tabulation of Water Rates, which occupies a considerable part of the volume, and gives extremely interesting and detailed information in regard to the source of supply, method of operation of water works, rates for charging, effect of electrolysis on mains, and provisions on the distribution system for most of the cities in the United States.

PAMPHLET 11 of the Murray Iron Works Co., Burlington, Iowa, describes in detail the new direct-connected generating sets as placed on the market by this company.

These units, which are made in 50, 75 and 100 kv.a. capacity, consist of the standard Murray-Corliss steam engines directly connected to especially designed Westinghouse alternating-current generators.

Embodied in the general description may be found detailed data of the various sized engines and generators, reproductions of indicator cards taken from a 12 by 24-in. Murray-Corliss engine and on the last pages, advantages of the independent electrical generating station are cited.

SOME APPLICATIONS of "Detroit" steam traps are illustrated in a folder recently issued by American Blower Co., Detroit, Mich.

BULLETINS NOS. 6 AND 7, covering the company's line of electrical pyrometers, were lately received from Thwing Instrument Co., 445 North 5th St., Philadelphia.

A NEW BULLETIN, No. 40, of Roto tube cleaners, gives a general review of Roto developments and list of special catalogs now issued by the Roto Co., Hartford, Conn.

BOILER TUBE CLEANERS and other tools are described and illustrated in Catalog H, from Liberty Manufacturing Co., 6910 Susquehanna St., Pittsburgh.

POWER PLANTS for textile mills are discussed in the Westinghouse Textile Quarterly No. 7, which illustrates a 750-kv.a. Westinghouse low-pressure turbine-generator unit. Methods of furnishing the power and for driving a mill from its own plant are given, also tables showing installation costs for the different cases and comparative operating expense for the addition to the old plant for the new plant.

HOW THE CHIEF ENGINEER was Convinced is the title of a booklet just published by the B. F. Sturtevant Co., of Hyde Park, Boston, Mass., describing a visit of a prominent engineer to the company's works, and dealing particularly with the manufacture of turbines. It tells and illustrates how each part of the machine is made, tested and finished. Copies will be sent on request.

A DEPARTURE in the matter of pipe for underground work is that cast-iron threaded pipe which is illustrated and described in a new catalog entitled "Pipe Economy," issued by James B. Clow & Sons, of Chicago. This outlines the use of such pipe for water and steam mains, both high and low pressures, for well casings, for overhead steam lines, and gas and air lines, where corrosion is liable. The book contains, also, full dimensions for the new American Standard flanged fittings, in regular and extra heavy weights, and shows the adaptation for some other Clow products. Messrs. Clow & Sons have taken up the manufacture and sale of the Eddy gate valves and swing check valves, and the book shows the construction and gives sizes for the entire line of iron and bronze mounted construction, with either taper or parallel seats.

THE LATEST BULLETIN, No. 20—Series 1, from American Blower Co., Detroit, Mich., was recently received. This contains 64 pages on the subject of dry kilns for timber products, illustrating different types of kilns, dry kiln specialties and methods of loading dry kiln trucks.

Trade Notes

GRATON & KNIGHT Mfg. Co., of Worcester, Mass., has opened a branch sales storehouse at 301 Magazine St., New Orleans, La., where a complete stock of its leather belting, lace leather, belt dressing and cement will be carried, and belt repairs handled to ensure satisfaction of customers. This new branch will serve the

entire state of Louisiana, and that part of Mississippi south of and including Jackson and Meridian.

AS THE RESULT of a trial of 2 Simplex blow-off valves since October of last year, Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., recently received a reorder from the Champion Fibre Co., Canton, N. C., calling for 20 Simplex valves.

THE TERRY STEAM TURBINE CO., Hartford, Conn., announces the appointment of Fidanque Bros. & Sons, of New York and Panama, with main office at 15 Whitehall St., New York, as its representatives for the Republic of Panama and the Canal Zone.

The company also announces that, on Aug. 1, its Cleveland office, in charge of L. G. Finlay, was moved from its former location, 710 New England Bldg., to 503 Union Bldg.

A NEW HIGH power water pump, with a capacity of 30,000,000 gal. a day, built by the Allis-Chalmers Co., was recently installed at the Broadway Pumping Station of the Toledo Water Works, Toledo, Ohio. It has the distinction of being one of the greatest pumping engines of its class ever constructed, and cost $83,000. The pump is of vertical triple expansion design. The cylinders and heaters are covered with 1½-in. J-M 85 per cent magnesia blocks, finished with ½-in. cement. The high pressure cylinders are insulated with 2-in. magnesia blocks and ½-in. cement. All steam lines are protected with J-M 85 per cent magnesia pipe covering. The insulating material was furnished by the H. W. Johns-Manville Co.

WESTINGHOUSE ELECTRIC & MFG. CO. reports the receipt of the following among orders for mine apparatus: Anaconda Copper Mining Co., Butte, Mont., 8 150-hp., 14-pole motors with impregnated winding, to be operated in couples of 300 hp., for driving quintuplex mine pumps; Anaconda Copper Mining Co., for the Boston & Montana Reduction Works, Great Falls, Mont., 2 8-ton barsteel locomotives; Daly West Mining Co., Park City, Utah, 1 175-hp, 16-pole motor with magnet switch hoist control, and 1 400-hp., 150-r.p.m., synchronous motor with exciter and switchboard, for driving a Laidlaw-Dunn-Gordon air compressor; Yukon Gold Co., Idatrod, Alaska, 6 125-kv.a., oil insulated, self-cooled transformers; Alaska Treadwell Gold Mining Co., Treadwell, Alaska, 1 4½-ton storage battery locomotive with 2 V-50 motors and 68 cells of Edison type A-B battery, 1 8-ton barsteel trolley locomotive with No. 905, 500-v. equipment, steel tired wheels, and D-20 trolley, also 1 No. 354 200-hp., 2200-v. motor with magnet switch control for automatic acceleration; Betson Copper Co., Latouche, Alaska, 2 625-kv.a., 80 per cent power factor, 2300-v., 3-phase, 60-cycle, normal rated turbo generator units, 1 6-panel switchboard, and 2 16-kw. motor-generator exciter sets; Tonopah Marger Mining Co., Tonopah, Nev., 1 250-hp., 200-r.p.m., synchronous motor with switchboard panel and motor-generator set for driving Sullivan machinery compressor; Burro Mountain Copper Co., Burro, N. M., 4 300-kv.a., 6 100-kv.a., and 3 37½-kv.a., oil-insulated, self-cooled transformers, for a new copper property being developed by the Phelps-Dodge Co.; United Verde Copper Co., Jerome, Ariz., 3 300-kv.a., and 3 30-kv.a., oil-insulated, self-cooled transformers for a new smelter at Clarksdale, Ariz.

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> "Slowly, though not imperceptibly, perhaps, a radical change has taken place in business morals. At the recent annual meeting of the American Chemical society one or two of the speakers referred to this change from a special point of view, but its significance is general.
>
> "One of the oldest rules of the common law is, 'Let the buyer beware.' This rule meant that consumers were supposed to purchase articles at their own risk; that it was their business to test, inspect, examine the things they bought, and that the sellers were not to be held to high standards of ethics and veracity. An amusing and familiar illustration of this is found in the dictum of a British judge that 'razors were made to sell, not to shave.' If a man bought a razor that failed to shave the fault and loss were his under the law, which assumed and justified a very low state of business morals.
>
> "Today, whether or not the law has marched with the times, business morals are higher. 'Let the seller beware' is becoming the rule of trade and commerce, as the chemical society pointed out. The buyers are no longer laughed at when they purchase razors that fail to shave. Such a transaction is frowned on by the business community as reprehensible and fraudulent. The sellers understand that they are in a position to test and examine the articles they turn out, and they are assuming this burden more and more. They realize that they can obviate injustice and deception at relatively small expense, and that honesty is the best policy in this as in other directions.
>
> "This remarkable change in business ethics, it is asserted, is creating a greater and greater demand for chemists, analysts, engineers, testers, and like experts. Here is a case where an improvement in morals directly makes for prosperity and increased employment. But it does more than this. In the day of Lord Bacon it was lightly supposed that a certain amount of trickiness and shiftiness was inseparable from trade and business. We are happily getting away from this demoralizing notion. Trade and commerce are forms of social service. These forms of service should be characterized by the strictest honor and the highest integrity. That they are so characterized in our day to an unprecedented degree is the strongest proof of the progress of society toward justice and righteousness."

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